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# The Trial Case and How to Use It

A Practical Treatise For  
Optometrists



*Illustrated*

*Fourth Edition, Enlarged and Revised*

*Robert McInturff BY*  
R. M. LOCKWOOD  
*60*

AUTHOR OF THE LOCKWOOD SERIES—PRINCIPLES OF  
OPTOMETRY, THE TRIAL CASE AND HOW TO USE  
IT, SUBJECTIVE TESTS FOR DIFFICULT  
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#### FOURTH EDITION—PREFACE.

In this the fourth edition of this work the author has carefully revised the text of the previous edition and materially added thereto. The previous editions were manuals which assumed a knowledge on the part of the readers of those ocular conditions which make the testing of vision and the correction of the same with lenses a necessity. In the present edition a description of these conditions has been added, so that those who make use of the work will find it complete in itself, with no necessity of seeking preliminary knowledge elsewhere in order to thoroughly understand it.

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## CHAPTER I.

### THE EYE; ITS FUNCTIONS AND CONDITIONS.

THE EYE.—The eye is the same as a photographic camera so far as its image-producing power is concerned, and corresponds to a lens of something less than an inch focus. It differs from a camera in the fact that it is not a simple lens, or a combination of simple lenses, forming an image at a certain distance to the rear, but rather a succession of transparent refracting living substances forming altogether one solid whole. Commencing at the front is the cornea, the transparent portion of the eye, which is exposed to the outside world. Behind this comes the aqueous chamber, so called because of the watery-like fluid which it contains; next the crystalline lens, which is bi-convex in form, then the vitreous, a jelly-like, transparent medium, and finally the retina, or the screen of the eye, in which the image produced by the succession of transparent bodies just specified forms a copy of external objects. The retina is really an expansion of the optic nerve, which consists of hundreds of thousands of individual fibres entering the ball of the eye from the rear and then spreading out on the inner surface of its hindermost portion to form the retinal screen. This retinal screen is very complex; is made up of nine distinct layers, all transparent, but the deepest one of all considered to contain those

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peculiar organs, the rods and cones, which are now assumed to fulfill the function of responding to the waves of light in such a way that the vibrations which they transmit to the fibres of the optic nerve are carried by the latter to the visual centers of

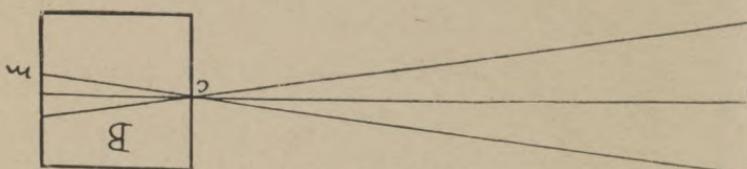


Figure 1.—PHOTOGRAPHIC CAMERA.

A.B.—Object.  
D.—Diaphragm.

L.—Lens to focus rays of light  
plate R.

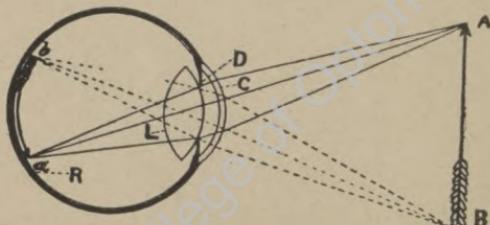


Figure 2.—THE EYE AS A CAMERA.

A.B.—Object.  
C.—Cornea, where first refraction occurs.

D.—Iris, which acts as a diaphragm.

L.—The lens where a further refraction occurs.

R.—The retina on which the image is formed.

brain, there to be interpreted in that mysterious manner which we call vision.

The eye is a globe, or almost one, of a diameter of about one inch. Its outer coat is very tough, far more so than it looks and this outer coat consists of three distinct layers. The inner one, the retina, has already been referred to. Next to and out

side of it is the choroid, which is thin and dark purple, and contains most of the blood vessels which feed the eye and carry off the products of decay, for the eye is a physiological instrument and, like all the other organs of the body, it is continually

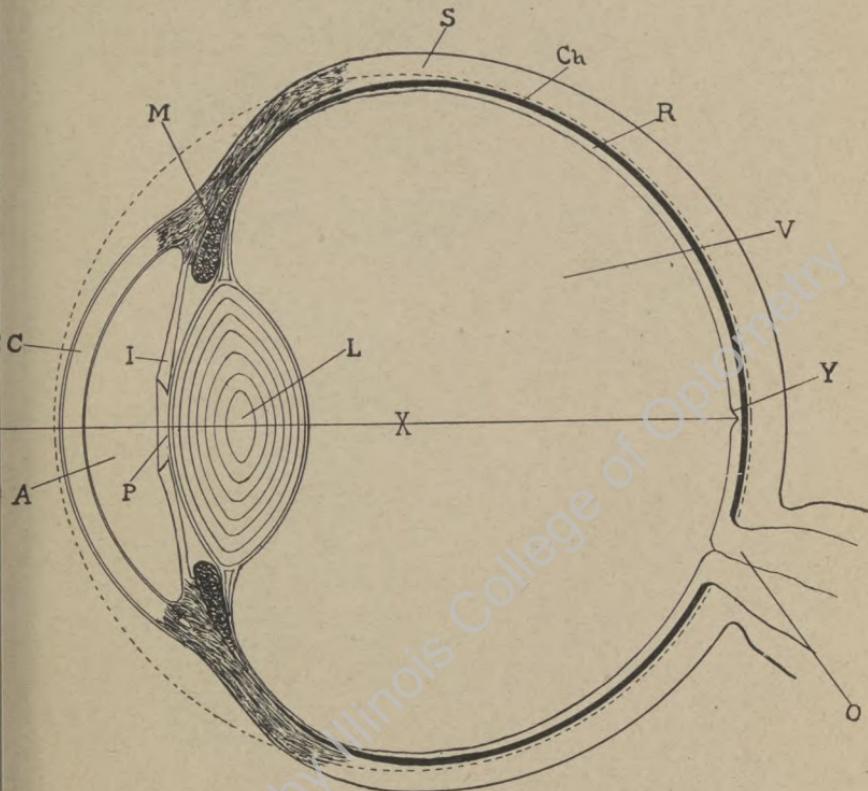


Figure 3.—THE EYE.

S.—The sclerotic.  
V.—The vitreous humor.  
Ca.—The choroid.  
Y.—The macula lutea.  
I.—The iris.  
L.—The crystalline lens.  
M.—The ciliary muscle.

R.—The retina.  
O.—Optic nerve.  
C.—The cornea.  
P.—The pupil.

wearing out and being renewed, or, in other words, there is continual circulatory current in the eye, and in all parts of the eye, which constantly brings in new food and carries away waste products. It is true that it is all transparent, or rather so in health, but at the same time this circulation is absolutely necessary, and its cessation for any reason means blindness in a few hours, while a partial choking up of the ducts is very apt to seriously interfere with vision and ultimately destroy it. Immediately outside of the choroid is the sclerotic coat, which is white and very tough. At the front of the eye this coating becomes transparent and then is known as the cornea.

In the center of the cornea is the pupil, which is merely the central portion not covered by the iris. It looks black, but is really transparent. The reason we cannot see through it ordinarily is that to see anything through a transparent substance there must be something more or less lighted up behind it, but in the case of the eye the only way for the retina to be lighted is through the pupil, and this will never occur so long as the head is in the way of the light, which it will always be when we attempt to look inside. By reflecting light into the eye from a mirror, in the center of which there is a tiny hole, through which we look, we will then see the back of the eye (the fundus), and the pupil will appear bright red, or orange, instead of black, due to the network of capillary blood vessels of the choroid showing through the transparent retina.

The eye is subject to many diseases, with few of which the optometrist can have any concern. The main thing that he should know in this connection is to detect opacities, whether due to cataract or to some other cause; and to be able to tell by simple inspection whether there is anything abnormal in the visible portions of the eye. For this purpose a condensing lens, the concave mirror and the ophthalmoscope are used.

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A NORMAL EYE.—From the point of view of the optometrist a normal eye is one which when it is in a state of physiologic rest can look upon far distant objects and see them distinctly; that is, the image of the distant object formed on the retina will be without the slightest diffuseness of image and

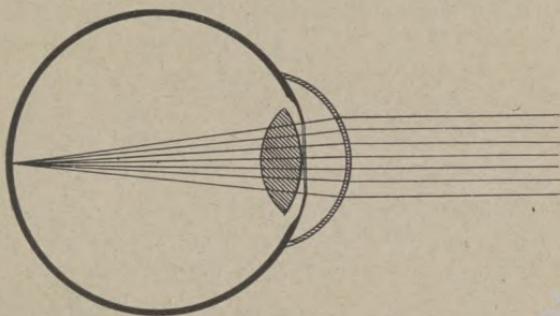


Figure 4.—A Normal Eye. Light Focuses Exactly on the Retina When the Eye is at Rest.

the form of the same is recognized. Such an eye is extremely rare, but it serves as a standard of comparison by which we may express the dioptric condition of any eye which is under test. Such an eye is said to be emmetropic. When the eye is abnormal from an optical point of view we call it ametropic. It is the sphere of optometry to supply glasses to ametropic eyes to bring them as near to emmetropia as the physiological and optical conditions will permit.

VISUAL ACUITY.—This is the ability of the eye to distinguish form. It varies within wide limits, though most eyes come close to the standard of Snellen; that is, the ability to distinguish the form of a letter when the letter is inscribed in a square which is five minute of arc each way, the width of the

strokes forming the letter in this space being one minute of a degree. For a distance of 20 feet the width of such strokes would be about  $\frac{1}{15}$ th of an inch. Those eyes which with the ciliary muscle at rest can distinguish the forms of test letters made to this size are the emmetropic eyes. For shorter distances the width of the strokes and the squares containing the letters would have to be reduced; for greater distances there would be an increase.

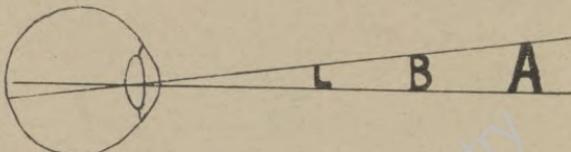


Figure 5.—A Five Minute Angle of Arc Showing Increasing Width with Increasing Distance.

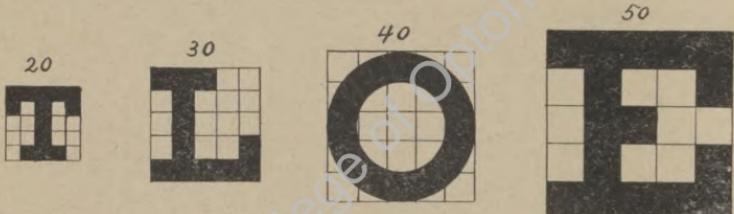


Figure 6.—Snellen's Letters for Different Distances, Shown in Feet with the Method of Constructing Same.

**ACCOMMODATION.**—Just back of the iris where it meets the sclerotic is a small circular muscle attached to a membrane, to the center of which is fastened the crystalline lens. Although the eye is a camera, there is one important point in which it differs from all other cameras. Its screen is fixed, and in order to see distinctly for all distances it must change its magnifying power. With an ordinary lens, the nearer the bright object on one side of the lens, the farther away must be the image on the other side of the lens, but with the eye there can be no movement.

of the screen which receives the image, hence the power of the lens itself is altered. The more the crystalline lens swells in the center the greater its strength, and the greater its strength the nearer the object must be to be seen distinctly. It is the function of the small circular muscle to produce these changes in convexity by loosening up the membrane, so that as this loosening occurs the crystalline lens swells. This property of the eye is called its accommodation. It is strongest in childhood, but steadily diminishes in power as we grow older until at about 65 years of age there is usually no more accommodation, and the eye is only in focus for just one point. This ocular process is called presbyopia, and all human beings, without exception, are subject to it. As a result of it all persons, except a few near-sighted ones, must wear glasses eventually to read, while others must also wear glasses to see well at a distance.

AMPLITUDE OF ACCOMMODATION.—This is the extent to which the crystalline lens of the eye can change its optical power being greatest in childhood and least in old age, as stated above, power at any given age, and varies with the age of the individual, but there are some exceptions to the rule of gradual progression from early to late years. In some cases the amplitude of accommodation falls off rapidly and unduly early, while in others it may remain unchanged through many years. Sometimes very old people are found to have considerable amplitude of accommodation.

FAR AND NEAR POINTS.—These are the two points which express the limits of the accommodative power of the individual. In the case of a myope they have an actual existence, and the same is the case with the emmetrope. In the former case the far and near points will both be within infinity, one

being the greatest distance at which the eye can see clearly and the other the nearest point at which this is true. In the case of the emmetrope the far point will be at infinity, but with hypermetrope only one of the points, the near point, can have an actual existence, and where the hypermetropia is high both points may be beyond infinity; that is to say, they will have no actual existence, the eye not being able to focus any rays on the retina, whether near or far. In this case they may be said optically to be behind the patient's head.

HYPERMETROPIA.—When the eyeball is deficient in depth, or the dioptric power of the crystalline lens of the eye is too low, then we have a condition called hypermetropia or hyperopia. In this ocular condition the ciliary muscle must act to increase the power of the crystalline lens so that the image of the distant object instead of blurring on the retina may form there a clear and distinct image. This often puts a great deal of work on the delicate ciliary muscle as compared with that in the emmetropic eye, in which there is no strain at all on this muscle. The possible results of this condition are several. First the eye will show presbyopia before it would were it emmetropic. Usually with the normal eye, glasses are needed for reading at about 40 years of age, but with an eye which is hypermetropic to a high degree this necessity may arise many years sooner, while in some extra high cases the glasses are needed in childhood. The average eye has just about so much ciliary power, and if, as is the case with a hypermetropic eye, half of this is used to overcome the optical abnormality of the eye, then only half of it is left for a reserve, which will of course be fully called upon long before the traditional age of 42. The second difficulty which arises with hypermetropic eyes is headache and eyestrain. Each individual has a certain amount of nervous force, and while there are some

who can give up the amount demanded by the ciliary muscle in easy hypermetropia, there are others who even with a very small amount of it will suffer from headache, especially after sightseeing, and in some cases as the result of remote nervous reflexes. Finally the ciliary muscle may take on a condition of "spasm" or "cramp," in which as the result of overwork the muscle may suddenly contract into a fixed position and simulate myopia. There is considerable difference of opinion as to the nature and extent of this spasmodic condition, some claiming that

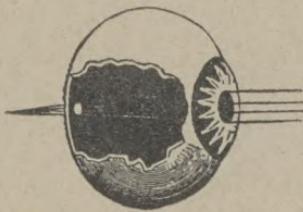


Figure 7.—A Hyperopic Eye.

The persistent spasm is hard to break up, others that it is only effective when the eye is in use, and that by "fogging" the spasm will relax. Tscherning dismisses the whole subject with the statement that "all spasm of the accommodation will relax promptly in the dark room." If this is true then certainly "fogging" is all that is necessary. In any event the optometrist must be constantly on his guard against this condition not to be deceived and prescribe the wrong lenses.

MYOPIA.—When the eyeball is too long, or the dioptric power of the crystalline lens of the eye is too strong, then we have a condition of myopia. Here in order that the image of a given object shall come clear on the retina, the power of the crys-

talline lens must weaken, but there is a limit to this, which is reached when the ciliary muscle is entirely relaxed. Myopes do not see at a distance, but do not have to wear reading glasses as soon as emmetropes and hypermetropes; in fact, some of them never have to wear them at all. For a normal eye in a young person the range of vision may be from 6 inches to infinity, while for a myope it may only be from 4 to 13 inches. In both cases they have about equal accommodative powers. It was laid down by Donders, and many others hold the same opinion, that a myopic eye is a diseased eye, and that the myopia is usually pro-



Figure 8.—A Myopic Eye.

sive and is due to civilization; that eyes were not meant for such close work as is common in schools, though of late years the opinion given out by Donders has been somewhat modified. I now hold that there are two sorts of myopia; one, non-malignant, which is the result of school life, and which runs to a certain point and then stops, and the other the true malignant variety, which has nothing to do with school. Germany is the home of the myopic eye and the condition arouses much concern there.

**ANISOMETROPIA.**—This is that condition of the eyes where the optical power of the two eyes is not the same. One eye may be emmetropic and the other either hyperopic or myopic, with or without astigmatism, in fact there may be any one of many combinations. Where one of the eyes is myopic and the other hyperopic the condition is sometimes called antimetropia.

ASTIGMATISM.—The human eye is far from being optically perfect and one of its most common defects is astigmatism. This means that ocular condition in which the different meridians

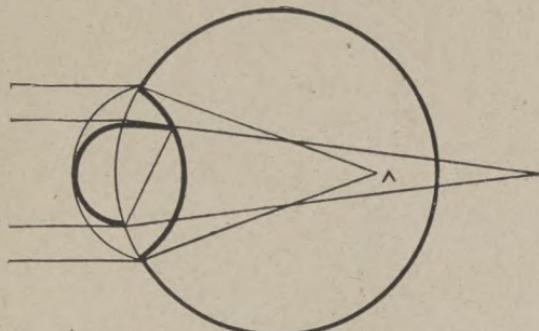


Figure 9.—Mixed Astigmatism.

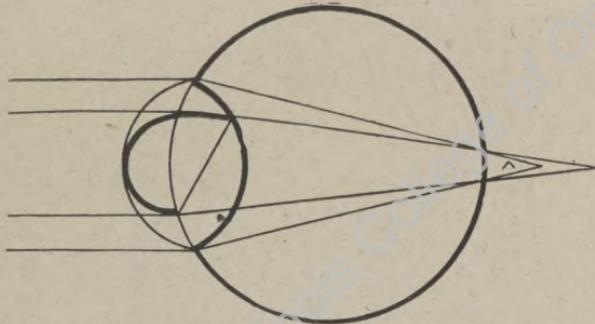


Figure 10.—Compound Hyperopic Astigmatism.

the eye have not the same power. If we put before such an eye a narrow slit, first vertical, then horizontal, and then in several other different directions, we may find one direction in which it shows a greater power than the others, and we will find another in which the power is less than all the others. The two directions,

one having the strongest power and the other having the weakest are the two principal meridians of the eye. Before we can get the clearest image possible on the retina we must make all the meridians of equal power. Astigmatism is extremely common, often of so little amount that the owner has become used to it and in fact is better satisfied with it uncorrected than the contrary.

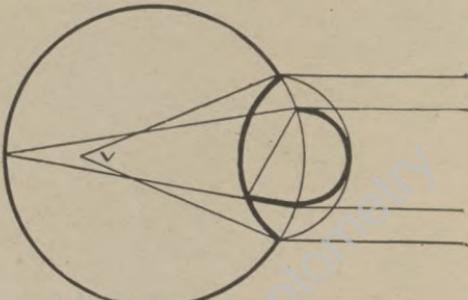


Figure 11.—Simple Myopic Astigmatism.

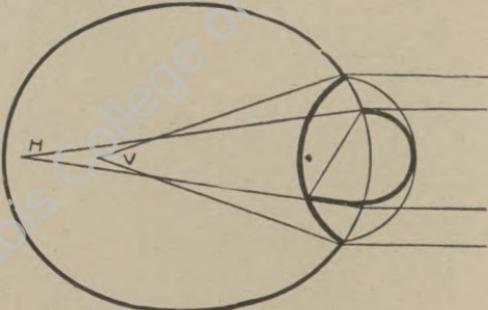


Figure 12.—Compound Myopic Astigmatism.  
where the condition is at all marked it often gives rise to the same symptoms as hypermetropia and is accompanied with poor vision.

Where the eye in both the principal meridians, with accommodation not in force, is hyperopic, the condition is called

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compound hyperopic astigmatism. Where both principal meridians are myopic then it is compound myopic astigmatism; when one of the principal meridians is emmetropic and the other hyperopic it is simple hyperopic astigmatism; when one is emmetropic and the other is myopic it is simple myopic astigmatism, and when one of them is myopic and the other is hyperopic it is called mixed astigmatism. No matter what the variety of the astigmatism may be, the finding of it is always by the same method of duplication of lenses. It is only when the test is completed that one can name the kind of astigmatism in a given case.

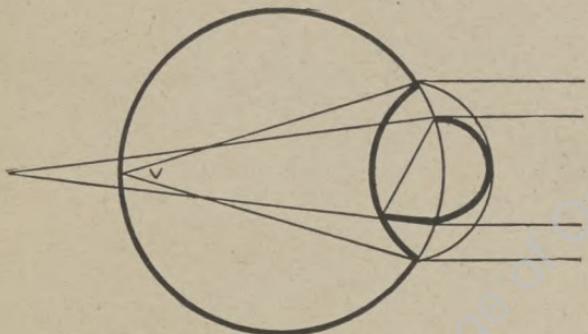


Figure 13.—Simple Hyperopic Astigmatism.

EXTERNAL MUSCLES OF THE EYE.—These are six in number, four pulling the eye (lightly) back against the capsule in which it rests, and two others acting with the check ligaments to pull the eye forward, thus keeping the organ in a state of equilibrium. These muscles act harmoniously together, so that in a normally functioning eye it may take any position required for good vision with correctness and ease. Where this is not the case, then we have a condition of heterophoria or muscle imbalance, which may result in headaches, eyeaches or other disagreeable symptoms, or else the eye may give up the struggle and

squint. Heterophoria is difficult to treat, prisms, muscle exercise and operations being the means used.

**CONVERGENCE.**—This is the power of the eyes to turn them toward some near object, and where this for any reason cannot be done the object is either seen doubled or else the impression received by one of the eyes is repressed, the other doing all the seeing. This function of the eyes does not fall off as does that of accommodation with increasing age, but where there is a deficiency it is either due to some pathological condition or else to lack of use. In the latter case it will usually come back with practice. The extent to which the eyes can be converged or can be diverged is called the amplitude of convergence, though it could equally well be called the amplitude of divergence. To get the greatest extent to which an eye will diverge from parallelism it is necessary to test with prisms, bases in, up to the point where single vision can be maintained.

**AMBLYOPIA.**—This means poor vision due to physical or pathological reasons; something wrong with the retina, the optic nerve or the visual brain centers. It cannot be corrected to any great extent by lenses at the time of the test. Cases of amblyopia cannot as a rule be fitted best with the trial cases. The skiascope has to be used; then if the amblyopia is due to non-use of the eye, useful vision may gradually return.

**ASTHENOPIA.**—This may be of two kinds, muscular and accommodative. In the first case there is strain on the external muscles of the eye, in the latter it is strain upon the ciliary muscle. In either case the symptoms are about the same; eyeache, difficulties with vision, and sometimes nervous affections, more or less hard to discover and relieve, whose connection with the eye

be hard to trace. Usually lenses and cylinders properly applied in spectacles will correct accommodative asthenopia, while for the muscular form we must have recourse to prisms, muscle exercises, or even operations.

PHOTOPHOBIA.—This is an intolerance of light, more or less pronounced. It may be due to sluggishness of the iris, undue sensitiveness or inflammation of the retina, and is common in all cases, or where the eyes have been subjected to a dazzling light, as well as in diseased conditions. It is properly a case for the practicalist, though tinted glasses are sometimes prescribed by the oculist to rest the retina. Only smoked glasses should be given this purpose.

DOUBLE VISION.—This is the seeing of two images of same object due to the two eyes not being converged on the same point. It is a symptom which always means recent trouble, if the two eyes have not converged for a long time, say since childhood, then vision has become suppressed in one of the eyes and the person does not know he sees double, hence he does not come to have the diplopia remedied. The fitting of such a case is not within the scope of this work. But there is a species of diplopia which appears during the test which will puzzle both the patient and the examiner; this is where the object is seen double with one eye only. We have to do here with the pupil of an eye where there are two different areas of refraction, one of which will have to be fitted and the other not. Such cases as this rule cannot be brought up to normal visual acuity, for when a clear image is formed on the retina by way of one pupillary area there is a blur over it because of the poor image formed by the other area, or vice versa.

NYSTAGMUS.—This is a rare condition in which the eyes

are in constant motion either from side to side, or the direction may be a rotary one. The patient is usually unconscious of movement, which is accompanied by poor vision. Glasses are little or no value.

MUSCAE VOLITANTES.—Flying spots seen by the patient; of no serious import and with no relation to the wearing of glasses. Usually shows a lowered state of health, and the spots disappear as the health improves.

COLOR BLINDNESS.—Not blindness at all, but the inability to recognize some one or more colors. If red cannot be recognized then there will be confusion between greys and reds; if green is the faulty color then greens will conflict with greys; if there is a deficiency for both red and green, then reds, greens and greys will be badly confused. People who are color blind usually have very good vision; they are deficient in color perception, not in form deception.

DAY BLINDNESS AND NIGHT BLINDNESS.—A few people say they can see much better in the dusk than in the bright daylight, while a few others see better in the daytime. The former may be due to a sensitive retina which is dazzled in a bright light, or it may be caused by an insensitive retina which requires that the pupil shall be wide open in order to see well, something which can only be when the light begins to fade away. Then again the cause may be in the pupil of the eye. If the center of the pupil is perfect and the periphery is not, then when the pupillary area is widened in the dusk the retinal image will be a confused one; while if the center of the pupil is irregular then the widening of the pupil in the dusk will bring into play a comparatively large area of pupil, which can produce a good retinal image, and in this

the person would see better in the dusk than in bright days or sunlight.

**MICROPSIA, MEGALOPSIA AND METAMORPHOP-**  
—All rare conditions. In the first objects appear too small, the second too large, and in the last distorted. However, when glasses are first put on any of these conditions may be noticed, though they soon pass away. This is especially true of the condition of high errors, and sometimes glasses will be rejected because of these appearances, but patience alone is needed to notice them no more.

—A few lines of text are given here to illustrate the effect of bright light on the eye. The former part of the page shows the effect of bright light on the eye, which causes the pupil to contract. The latter part of the page shows the effect of dim light on the eye, which causes the pupil to dilate. The area around the pupil is also affected by the change in light intensity.

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## CHAPTER II.

### MEANS EMPLOYED IN TESTING.

METHODS OF TESTING.—There are two general methods of testing eyes, the subjective and the objective. In the former we depend upon what the patient says in response to our questions as we apply our various tests. In the latter we judge for ourselves by what we actually see. Both methods have their place in optometry, but the subjective test with the trial case is the optometrist's court of last resort, and everything is checked up by it.

TEST TYPE FOR DISTANCE.—Twenty feet has come to be the standard distance for testing eyes for all uses except near work. The rays of light coming from this distance are so nearly parallel that the slight error is disregarded. The letters on the chart are usually black on a white ground, and figured for definite distances, the distance for which the different sizes are calculated being marked above each line. These types may be used at less than the regular distance of twenty feet, but in this case allowance must be made for the decrease in distance. With these types we are able to express the visual acuity either with lenses or without. In doing this we make use of the fractional method, the numerator being the distance of the type and the denominator the size. A child, corrected, if necessary, with lenses, may have a visual acuity of 20/15; an adult under the same circumstances

20/20; an elderly person 15/20. Where this result cannot be reached, the eye is visually below normal. Sometimes a still better result can be obtained, and in this case the eye is above normal, but these cases are rare.



Figure 14.—Test Types.

**TEST TYPE FOR NEAR.**—There are two varieties of this type, one Jaeger's, which is nothing more than ordinary type from the printer's font graded from the very finest up, and the other Snellen's, which is similar to the distance type, but decreased proportionately in size to correspond with the short distances at which it is used. With this type we find the reading point and the acuity of vision for a short distance. Normal eyes should be

able to read the very finest type on the reading chart at a distance of 13 inches. Many eyes can do even better than this when properly corrected with glasses.

CLOCK DIAL CHART.—This consists of a series of radiating lines with outer circles, and usually with Roman numbers

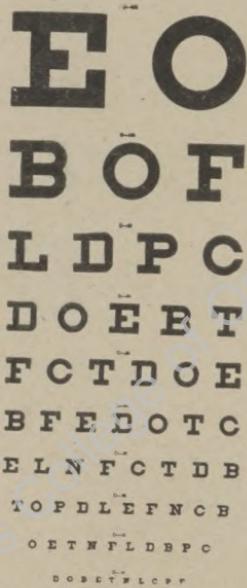


Figure 15.—Test Types. Another Arrangement of Letters.

arranged to correspond closely with the dial of a clock. It is used in connection with cylinders for the detection and correction of astigmatism. The Roman figures are used to name the radiating lines, those which are vertical being called the XII to VI lines; those which are horizontal being called the lines from IX

to III, etc. The values of the lines are sometimes also read off in degrees; the IX being zero, X 30, XI 60, XII 90, I 20, II 150, and III 180. This numbering is in the contrary direction from that of the trial frame, but this is necessary to make the two agree, since they are used facing in opposite directions. There are many other line-tests for astigmatism, but they are all based on the same principle of sets of lines.

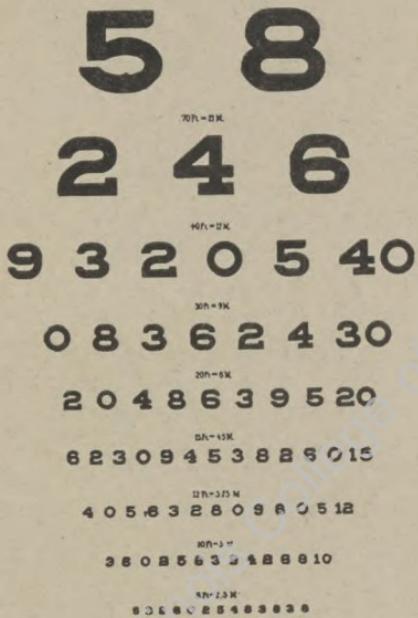


Figure 16.—Number Test Types.

**PLUS LENSES.**—These are magnifying glasses. They converge the rays of light, and if the object is far enough away, they will bring all the rays of light from this object to a focus, where they will form an image, a duplicate of the object in form

illumination and color, but inverted. In the trial case there are many of these plus lenses arranged on the dioptric system and graded from the weakest to the strongest. Their values are marked on the handles, the fact that they are plus being shown usually by a cross stampel in the metal.

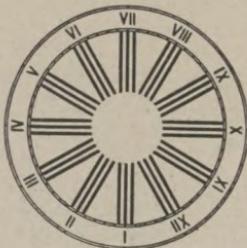


Figure 17.—Clock Dial Chart.



Figure 18.—Fan Chart.

MINUS LENSES.—These are magnifying glasses. They diverge the rays of light, and do not form an image of the illuminated object, no matter how near or far away it may be. These lenses are arranged in the trial case in the same way as the plus lenses, their handles being usually stamped with a minus, and sometimes gilded.

DIOPTRIC SYSTEM.—Lenses are now numbered as follows: A lens forming on a screen an image of the sun at a distance of 40 inches is of 1 diopter; a lens twice as strong, or one forming an image of the sun at 20 inches is a 2 diopter lens; a lens which is three times as strong, forming an image of the sun at 13 inches, is a 3 diopter lens, etc. The lenses in the trial case

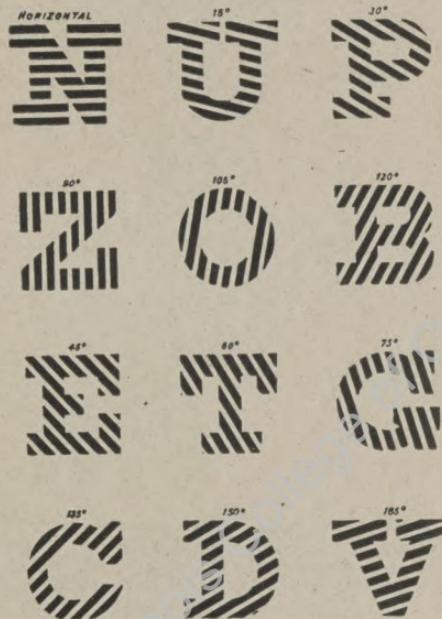


Figure 19.—Pray's Astigmatic Letters.

are numbered in this way. To find the value of two or more of them together combine the values as shown on their handles. The old system was based on French inches, which are not exactly the same as English inches, but one system may be turned into the

other, accurately enough for all practical purposes, by the following rule: To change from diopters to inch system divide 40 by the value in diopters, and the quotient will be the value in the inch system. To change from the inch system to the dioptic divide the inch number into 40, and the quotient will be the corresponding value in diopters. The reason we use 40 is that the

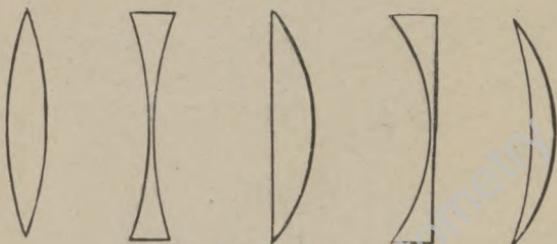


Figure 20.—Kinds of Lenses.

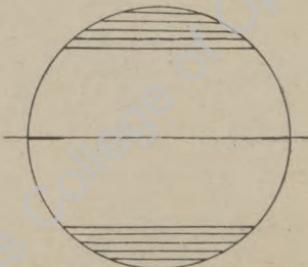


Figure 21.—The Axis of a Cylinder.

dioptic system is based on the meter, which is 39.37 inches, and 40 is so close to this that it is universally used because of its convenience in calculation.

CYLINDERS.—These are lenses which are ground in one direction only. Look at the chimney of an argand gas lamp,

or at a stove pipe, which is cylindrical; the outer surface of this will show the curved surface of a plus cylinder, while the inner surface will show the curved surface of a minus cylinder. One of the surfaces of the cylinders of the trial case is plano. These cylindrical lenses are marked on their handles in the same way as the plus and minus spherical lenses, but in addition their surface for a short distance near the periphery, and parallel to the direction in which there is no curvature, is usually frosted. This

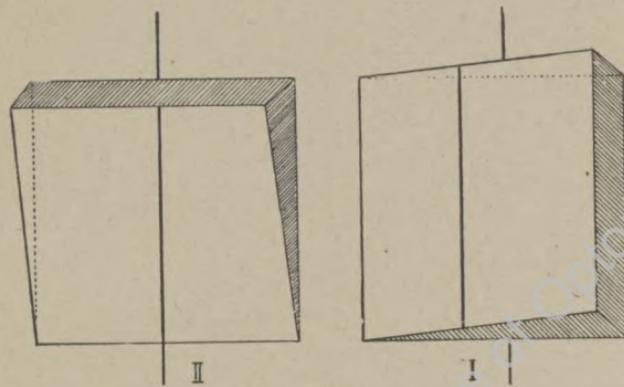


Figure 22.—Prisms.

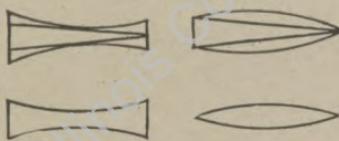


Figure 23.—Prisms in Lenses.

shows the direction of the axis of the cylinder which has no dioptric power. Referring again to the argand burner chimney, the axis corresponds with the long way of the chimney.

PRISMS.—These are wedges of glass which have neither magnifying nor minifying power, their two surfaces being plane. Rays of light in passing through a prism are bent towards the thickest part of the wedge, called the base, the thicker the wedge the more the bending, while the eye looking through a prism in order to see an object in any selected direction must turn from the direct line of sight towards the sharper edge, or apex, of the prism. Under these circumstances the eye is looking around an angle. Prisms are usually marked with a figure followed by a little circle to show the number of degrees that deviate a ray of light. There are other ways of marking prisms, called the prism diopter and centrad. The mark for the prism diopter is a triangle—the Greek letter *delta*. They are both scientific in theory, and the former of the two is much used. They will not be discussed here any further than to say that prism diopters and degrees are nearly the same. In many cases there are both circular and square prisms in the trial case, the former to be used with the trial frame and the latter with the figures.

OPAQUE DISC.—This is a solid piece of metal or rubber, circular in form, to fit the trial frame. It is used to shut off one eye while the other is being tested. Modern optometry is based on testing each eye separately, and while this is being done the other eye should remain open, so as not to tire out the patient. The opaque disc produces this result.

GROUND GLASS DISC.—This is used for the same purpose as the opaque disc, but the operator can see the eye through from the outside, which in certain cases is an advantage.

PIN-HOLE DISC.—This is the same as the opaque disc, but with one modification. Its center is pierced with a very fine hole through which the patient must look. It has the same effect

cutting down the size of the pupil, and this results in cases of metropia in reducing the circles of diffusion formed on the retina, with the result that the outlines of the object looked at become clearer. It is true that at the same time there is much loss of light, due to the smallness of the hole, but the clearness of form attained more than offsets this. Any eye that can be improved by this test can be improved by lenses. There is scarcely any exception to the rule.

**STENOPEIC DISC.**—This is an opaque disc in the center of which there is cut a narrow slit. With it we can test any meridian of the eye. It is used in some cases to detect and correct astigmatism. It has one objection; the size of the pupil of the eye varies with the amount of light which passes through it to the retina, and since the stenopeic slit cuts off a large part of the light, the pupil will dilate unduly and the peripheral part of the lens will come into play. As this peripheral portion is sometimes of a differing power from the center, a false finding may affect the result.

**MADDOX ROD.**—This is used to uncover heterophoria. It consists of a glass rod attached in front of a stenopeic slit. The small glass rod acts as a strong cylinder, thus causing a light, such as a candle flame, to appear as a long streak about the width of the flame. The difference in the appearance of this from the handle flame itself deceives the eye, and if there is a tendency to heterophoria the weak muscle will take a position of comfort, since the mind fails to realize that the two bright objects, as seen by the two eyes, one with the rod in front of it and the other not, are one and the same; hence the fusion sense is not in play.

**DOUBLE PRISM.**—This a solid piece of glass made in

the form of two prisms, base to base. It is placed over the eye so that one-half of the pupil is behind one prism and the other half behind the other prism. This causes the eye to see the light double. By using a red glass over the other eye, or even without any such glass, the patient will see three lights, the upper and lower ones being the two images on one retina, caused by the double prism, and the central one coming from the other eye. The result here is the same as with the Maddox rod. The eye is deceived and the muscles take a position of ease. The position in which the central light seems to have with relation to the outer ones is the measure of the heterophoria, if such exist.

TINTED PLANOS.—These are graded as to the obscurity of the tint, and have been used as sufficient in cases of phot-

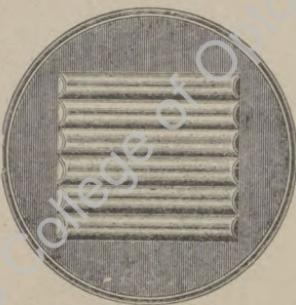


Figure 24.—Multiple Maddox Rod.

phobia, but this practice is decreasing, since photophobia has come to be looked upon as rather a serious symptom. Where the optometrist does prescribe them, the tints should be "smoke," not colors, as the latter are considered to be bad for the eyes. It seems to be necessary for the proper functioning of the retina that it should receive white light; that none of the spectrum colors

should be missing. Colored glass cuts off some of these colors, a hoke tint does not, only decreasing the amount of each color blurring the eye.

**PLANO LENSES.**—There is little call for these in optometrical practice, but sometimes they are employed to detect malingeringers; for instance, children who want glasses just for books. These planos are also used in testing eyes of marked visual acuity, where a lens which is correct will seem to be not as good as the naked eye because the glass absorbs some of the light and therefore makes the test card apparently not so clear. In these cases when a lens is tried it must be used in comparison with a phorano, so that conditions of illumination of retina may be equal.

**COLORED GLASS DISCS.**—These are generally red and green. Either may be used in the Maddox rod test and the two can be used together in the FRIEND test for malingeringers. In cases of marked hyperphoria the colored glass discs alone, the red or the green, over one eye will be sufficient to show that the condition exists, though the Maddox rod is the best in routine practice for this purpose.

**COBALT BLUE GLASS.**—This is a special test based on the supposition that if the rays of light from a source of illumination are cut down to the red and the blue, the accommodation will relax and thereby permit the ocular condition to be diagnosed by the appearance of the light. The glass used for the purpose is apparently blue, but really allows both red and blue to freely pass while all the other colors are almost entirely cut off. Since red and blue are unequally refrangible, there will be two images of the same formed, one blue and the other red, the blue being nearer to the crystalline lens. If the retina of the eye corresponds with

the focus of the blue rays then there will be a clear blue image which is superimposed the red image, but diffused. This will give the appearance of a blue center with a red border. The contrast will be the case if the retina corresponds with the focus of the red rays, while for an intermediate point the two images will both be slightly diffused and will coincide in size. By these different ap-

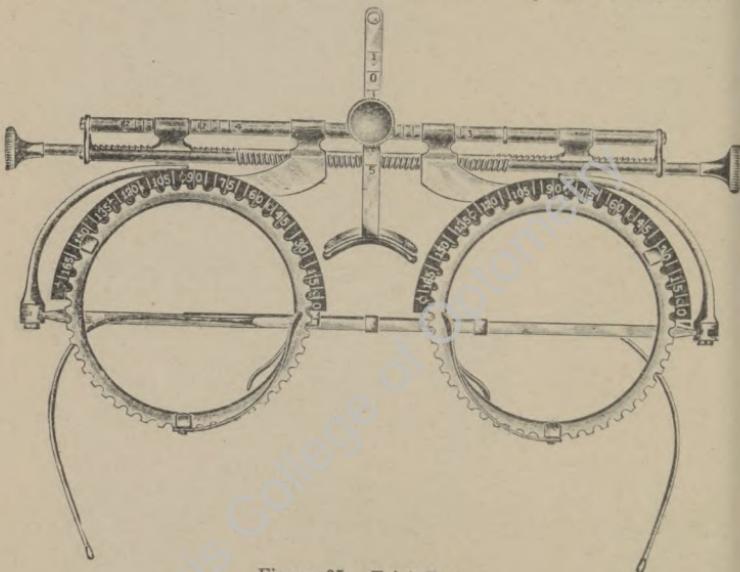


Figure 25.—Trial Frame.

pearances of the two colors the refraction of the eye is known. Astigmatism is known by the change in the shapes of the two colors. This test is perfectly reliable where there is no accommodation, but otherwise is more or less uncertain.

**SCHEINER'S TEST.**—This is a very old test. It consists

an opaque disc pierced by two very small holes close together. The eye under test must look through both holes at the same time, the light used being small and bright. The appearance of this light, sometimes single, sometimes double, will give the refractive error of the eye. The test is moderately reliable, but difficult to apply, as it is not always certain that the patient is looking through both holes at the same time, and this is necessary for the success of the test.

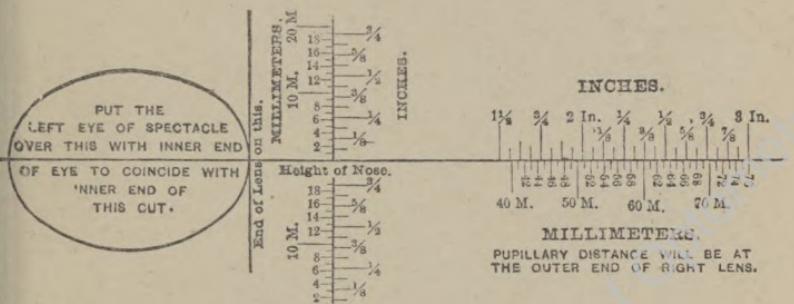


Figure 26.—Measuring Card.

TRIAL FRAME.—This is a pair of spectacles made especially for testing. By suitable adjustments it may be made to fit any eye, and by its calibration, if this is correct, the size of the spectacles to be worn can be read off. It contains over each eye two or three "cells" or receptacles for holding the lenses and various tests from the trial case, one or more of these cells being arranged that the lens or test placed in it may be revolved. This is especially for cylinders. On account of the weight of the trial frame it is an instrument of torture for some people, and care in these cases must be cut down to the smallest space of all possible. It does not always give satisfaction in taking trial measurements, due to errors in the calibration and to loose

joints. Facial measurements are usually and preferably take with a small ruler divided into millimeters on one edge and thirty seconds of an inch on the other.

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## CHAPTER III.

### CONTENTS OF THE CASE.

The complete trial case for optometrical work usually consists of the following: A graded assortment of bi-convex and bi-concave spherical lenses of from 0.12 diopters to 20 diopters; a similar assortment in plus and minus cylinders; a graded set of lenses, both circular and square, marked by their apex angles, of from 0.12 to 20 degrees or more; or they may be marked in prism diopters; a three-cell trial frame; and the following special testing pieces: Plano lens, tinted plano lenses, Nos. 1 to 6; ground glass globe, opaque disc, pin-hole disc, stenopeic disc, red glass, green glass, cobalt blue glass, Maddox rod and double prism, the latter for muscle tests. Sometimes there are special discs, such as Scheiner's and the cone prism test. Such a case will cost \$75.00 or more.

At the other end of the scale we find the pocket case. This contains a limited number of lenses and discs, varying somewhat with the different dealers, but the following will be found to be a good selection: Plus and minus spheres in pairs, sizes 0.25, 0.50, 0.75, 1, 1.50, 2, 2.50, 3 and 4 diopters; minus or plus cylinders in pairs, 0.25, 0.50, 1, 1.50, 2.25 and 3 diopters; five testing discs; ground glass, pin-hole, stenopeic slit, Maddox rod and red glass. With this outfit and a plain two or three-celled trial frame, ninety

per cent. or more of all cases may be fitted, provided the optometrist is good at figures, since combinations with so limited an assortment will usually have to be calculated. Such a pocket cass-



Figure 27.—Large Trial Case.

may be purchased, including the plain three-cell trial frame, for \$15.00 or less. By adding to the outfit a few high power spheres,

plus and minus, the percentage of cases which may be treated will be still greater.

Between the two extremes above mentioned there are all grades of trial cases, at all sorts of intermediate prices. Each one



Figure 28.—Small Sized Trial Case.

must decide for himself just how far he can go, bearing in mind always that the more complete the trial case the more professional

it will seem, and the less the optometrist will have to make calculations.

The method of trial case routine in this work will be so presented that the tests may be made with any variety of outfit within the limits stated.

#### APPLIANCES FOR USE WITH THE TRIAL CASE.

To properly meet all emergencies, the assortment of test cards to be used with the trial case should be as complete and varied as possible. There ought to be one or more of Snellen's distance test cards, each lettered differently from the others, and, if pos-



Figure 29.—A Lens from the Trial Case.

sible, a special form of this chart in which the letters on each line are of decreasing size. Also there should be a Snellen's test card for distance in German letters; the E illiterate chart; the picture chart for young children, and the clock dial and other astigmatic charts. For reading distance there should be the Jaeger or the Snellen near chart. For testing the ocular muscles for close work there should be the red and black Maddox near test, to be used with a single prism. This latter chart is figured for a distance of 10 inches, and it would be well to also have one figured for 16

ches. For taking facial measurements there should be either a properly marked ruler or else some of the special devices used for this purpose and to be had of the various dealers, or possibly, what is better still, a set of sample frames containing plano lenses and marked with a scratch to show their geometrical centers. For measuring out the glasses on their return from the prescription use a protractor card, and for quick work a lens measure, are also needed.

The optometrist who must limit his purchases in these directions can get along, if he has to, with the distance letter chart, a near chart and the clock dial chart.

The usual distance at which trial case tests are made is supposed to be 20 feet. This distance is often stated to be the same practically as infinity, so far as fitting glasses is concerned. This is not correct. If an eye is fitted exactly for an infinite distance, such as a bright star, then by a chart at a distance of 20 feet it is misfitted to the extent of about 1-6 of a diopter, so that it will sometimes be found necessary to allow the nearest to this in the trial case, which is 1-8 D. Then, again, it is not always possible to get 20 feet of space. In this case the optometrist must get along with less, but should never forget that in the prescription a suitable dioptric allowance is to be made to make the correction right for infinity, the same to be in the form of an increase for minus glasses and a decrease for plus. Where the distance is ten feet or a little less a good plan is to use the reversed letter charts with a mirror. These may be had of all the dealers.

The distance letter charts should be brightly illuminated. There is a rather general belief that the chart should receive only moderate illumination, so that it may correspond more closely with natural, every-day conditions. This seems plausible enough, and yet there is little logic in it. In the first place, there is no standard of every-day illumination, and, secondly, what we are

primarily seeking to do is to find the dioptric condition of the eye, and this can be best done by bright illumination, the brighter the better within reasonable limits, that is, within the dazzling point. The light which shines upon the distant reading charts should be shaded so that the eye of the patient may receive little of the light, and this light should also be arranged, as a matter of convenience, so that the screen in front of it may be removed and the light itself, with a perforated screen in front of it, used for testing muscle imbalance, if so desired. The trial case also should be sufficiently illuminated so that the numbers and marks on the handles of the lenses may be easily read. To see the scale of degrees on the trial frame there should either be a hanging electric light, which could be readily swung into position, or else a mirror could be used to reflect the light to the desired point. The astigmatic clock dial, as well as all other tests for astigmatism, when used, should be exactly at right angles to the line of sight. Where the charts are movable and so arranged that they can be brought in and out of sight from behind a screen, there should be counterweighed cords running across the ceiling and down to the optometrist's hand. Back of the patient and convenient to the eye of the optometrist there should be small cards which are duplicates of the distant test charts, so that he may know whether his patient is making mistakes or not, without needing to turn and look across the room. When we are testing a patient, we should be relieved of all possible inconveniences, so we may keep our minds constantly on the test itself; and for this reason it is necessary to have everything arranged conveniently.

## CHAPTER IV.

### THE PRELIMINARY TESTS.

There are certain points, as many of which as possible ought to be cleared up before the optometrist can advantageously begin to apply his subjective tests with the trial case apparatus. These will be given here in a routine order.

GENERAL INSPECTION.—In the first place, the patient should always remove his or her hat, or else the optometrist may be put to considerable inconvenience. This being done, throw a light on the eye from the side. If the eye is inflamed, or secretions of any kind are present, it may be necessary to refuse to go further with the case. Sore eyes are usually contagious, and some of them are of a very serious nature. In case of the slightest doubt, no chances should be taken of carrying infection by means of the trial frame either to the optometrist himself or succeeding patients. If no inflammation or secretions be present, which will usually be true, then the pupillary reaction should be noted. To this end the light should first be pushed back so that the patient's eyes are in darkness, and then it should be brought forward quickly so as to shine directly into the eye, but to one side. The pupils of the eyes, under the stimulus of the light, should contract promptly and rapidly. If there is no contraction, or it is very slow, the optometrist will often have the reason at once why

there are certain troublesome symptoms, such as photophobia, retinal fatigue and consequent nervous reflexes.

The cornea and iris and adjoining parts should now be noticed to see if there are any malformations present which would tend to reduce the visual acuity.

Some claim that the shape of the head and the face will tell the nature of the optical imperfection, but for this the writer will not vouch. He will simply state here what is claimed in this regard: "Flat face, hypermetropic eye; long face, myopic eye; non-symmetrical face, astigmatism; large and prominent eyes, myopia; small eyes, hypermetropia."

**THE HISTORY OF THE CASE.**—This is one of the most important points. There are some optometrists who consider themselves belittled if they ask the patient any preliminary questions. They take the ground that it is their place to find out the ocular condition by the use of their optical appliances alone. We can take a little instruction on this point from the physicians. Those of us who are familiar with the work of the medical practitioner and student know how much stress is laid on the "history of the case" and how much time is given to it. There are several things which, if possible, we should find out by interrogating the patient.

Why does he wish glasses, and has he ever worn them before? If so, for how long and with what results?

What particular ocular symptoms does he notice? Is there dimness of vision, either permanent or temporary?

Does he have hard work to read, and does the print ever seem to dance or swim?

Does he see double, and looking in which direction, or do dark spots ever seem to come before his eyes?

Are there headache, eyeache or burning sensations in the eyes, and when?

Are there excessive winking, or flow of tears, or sore eyes in the morning?

Is a bright light troublesome? Can he see better at night in the daytime?

Has he ever had eye disease of any kind, and has any one it drops in his eyes recently?

To ask categorically all of the above questions would be an unnecessary waste of time, but the patient should be skillfully led to give the information, or as much of it as the inspection of the eyes would seem to make necessary, though there should be no rambling allowed; this being kept in check. Meantime the preliminary tests, as here described, should be going on. Should the patient be uncommunicative, we must get what information we can. Still one more point is essential, especially with presbyopes, and that is to get and measure out the power of the lenses previously worn. Because a patient has a certain amount of either presbyopia or ametropia, it does not follow that full correction should be prescribed. With a knowledge of what the patient has last worn, the question of what to have him wear next is more easily settled. When this information cannot be had, we may unknowingly give the patient what he already has. This he will soon discover when he tries on the new pair and compares them with the old pair at home; then he will return to investigate, which will not always be pleasant. To get the strength of the glasses which he has previously been wearing is just as convenient as it is for a physician to know what medicine the patient has previously been taking. It is true that he can get along without the knowledge, but he will do better with it. In fact, he might unwittingly give his patient the same old prescription, which he will recognize, with corresponding loss of confidence.

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LOOKING IN THE EYE FOR OPACITIES.—This is rapid test, mainly for the purpose of discovering if there are any signs of cataract. It is made with the regular concave retinoscopic mirror at a distance of about 24 inches from the eye under test. Let the light be about one meter distant; have the patient look *in* a little towards the nose; now reflect the light into his eye and the red fundus will immediately come into view. If there are any opacities present, either corneal, lenticular or in the vitreous they will appear as black spots against the red background of the fundus. Where the observer's own eyes cannot accommodate for a distance of 24 inches, he should attach such a lens behind the concave mirror as will enable him to do so. The object of this is to cut down the corneal reflex to the smallest possible size, and this will be the case when the observer's eye accommodates properly for this image; otherwise it will be blurred and therefore occupy an increased space on his retina, thus hiding, perhaps, some opacity.

Where the pupil of the patient's eye is very small so that the fundus cannot be seen it will be necessary to first put a high plus lens in the trial frame.

THE COVER TEST FOR MUSCLE TROUBLE.—Direct the patient to look steadily at a small light across the room. Hold a card before one eye and watch it from behind the card. Now move the card to cover the opposite eye. Repeat in the reverse direction. Do not be too quick to make the transfer of the card. Wait a few seconds for the eye to become fixed. If, when the card is removed from in front of either eye, there is a jumping movement of the pupil, then there is muscle imbalance present. Should the cover test develop any motion of this kind, then the following muscle test should be made: Place over the right eye of the patient the Maddox rod disc, and over the left eye a rec-

ass, unless the Maddox rod is made of red glass, when a green glass may be used instead. At the opposite side of the room have a gas or lamp flame, in front of which is a screen pierced by a hole one inch in diameter. Let the patient sit at a distance from the flame of 9 feet 6 inches. Turn the test in the trial frame until the rod is horizontal. Now cover first one eye and then the other alternately until he has located both lights, one being the one-inch flame colored green and the other a long streak of light. Take away the card altogether and he will see the two forms of light at the same time, though at first he may have a little trouble in this regard, but this soon passes. Now let him describe to you the relative positions of the two lights; how far to one side the streak is, and on which side. Have him express their distance apart in terms of the diameter of the flame. If the distance from the center of streak to center of flame is one inch, the diameter of the flame, then he will have heterophoria to the extent that a one-degree prism will correct; that is, for every diameter of the flame the centers of the two lights are apart there will be required one degree of prism to correct the heterophoria. This applies, as stated, to a one-inch flame at a distance of 9 feet 6 inches. Make the distance half of this and the flame would have to be but one-half inch in diameter. The optometrist will find that the muscle trouble can be discovered by this method in less time than it has taken to explain it. Every one is familiar with an inch, and when the patient is told that the flame is one inch wide, and then asked how many inches the centers of the circle and disc are apart, he will answer correctly.

With the Maddox rod, as stated, over the right eye, if the vertical streak should be to the right of the center of the circle of light, then there is esophoria; if to the left, exophoria. Now turn the Maddox rod the other way, vertically, which makes the streak of light horizontal, and test for hyperphoria. The Mad-

dox rod being still before the right eye, if the streak is above the circle, then the right eye looks down, or what is the same thing, the left eye looks up, and we have left hyperphoria, while if the streak is below the center of the ring of light, then there is right hyperphoria. The method of making one inch at a distance of 9 feet 6 inches correspond to a one-degree prism (not a prism diopter) is practically correct to 20 degrees. Above that there is a steadily and rapidly increasing error. It is not absolutely necessary to use a green glass; no glass at all will do, but the green glass is easier on the patient's eyes, but where the Maddox rod is white a red glass over the other eye may be used.

**COVER TEST TO DETECT STRABISMUS.**—This condition, or, as it is also called, squint, is that state of the eyes where there is actual deviation, not simply a tendency to it. It can be detected in most cases by the following test: Have the patient look at some small, bright, distant object, at the same time holding a card in front of one of the open eyes. Now, while watching the uncovered eye intently, suddenly drop the card so that the patient sees the object with both eyes instead of one. If the eye under scrutiny is seen to move to fix the object, then strabismus is present, for on dropping the card the eye behind the same fixed the object while the other moved aside. This test should be made in turn with each eye. It is essential that the eye which is not covered with the card be the one that is watched.

**VISUAL ACUITY FOR DISTANCE.**—Visual acuity depends on several factors. The size of the objects looked at, the contrast in color between the objects and their surroundings; the illumination; the width of the pupil of the observing eye; the condition of the retina, the optic nerve and the visual centers of

the brain; and finally upon the perfectness of the eye as an optical instrument. The standard used for optometrical work is the Snellen's chart when under a bright illumination. This the normal eye should see distinctly at the distances as marked on the chart. The patient should be directed to look at the letters and to read down as far as he can with both eyes, and then with each eye singly. A record is to be made of the result for future comparison. This is with the naked eye. In making this record the following method is used: Express the visual acuity as a fraction, the numerator being the number of feet which the patient is distant from the chart and the denominator being the number of the type. 20/20 means that 20-foot type can be read at 20 feet; 20/15 that 15-foot type can be read at 10 feet only; 20/60 partly means that part of the 60-foot type could be read at 20 feet, but not all the letters. In using the test letter chart it will be noticed that some letters are easier to distinguish than others. The Snellen chart has its letters all drawn to scale, the various parts of the letters being one minute of arc wide, and the letter as a whole occupying 5 minutes of arc. This is the size which an eye or normal visual power is supposed to be just able to make out. The letter O is, however, much more readily distinguished, 3 minutes of arc usually being sufficient, while the letter L can often be made out with 2 minutes of arc. Then, again, young people as a rule will see better than normal, say 15/20, while aged persons can rarely do better than 15/20. Where these visual acuities are reached it is sometimes assumed that there is neither myopia nor astigmatism present.

VISUAL ACUITY FOR CLOSE WORK.—This test should be made with the near type, either the Jaeger or Snellen. The patient should be allowed to hold the printed matter at any

distance he chooses, and the record should show this distance as well as the smallest size of type that he can read. The two eyes should be tested together first and then each eye separately. Records can be made similar to the following: No. 1 at 20 inches, No. 7 at 8 inches, etc. It would, of course, be better to use the same notation as with the distance chart, but usually the near test charts are not marked on the Snellen basis.

THE FAR POINT IN MYOPIC EYES.—Hold the near type at a distance of six feet or so from the patient and then draw gradually nearer until the letters come clear. If at the distance of six feet the letters are blurred, but come out clear when the chart is brought nearer, then there is myopia present, and the point at which the letters are first clear is the far point for that particular eye.

THE FAR POINT IN OTHER CONDITIONS.—Where the eye is not myopic it will not be possible to get the far point except by first applying plus lenses and then making allowance for these in the finding, this due to the fact that the far point for emmetropic eyes is at infinity, and for hyperopic eyes is behind the eyes, that is, virtual.

THE NEAR POINT IN OTHER CONDITIONS.—In many cases of emmetropia and hyperopia the near point can be found the same as in cases of myopia, but where there is insufficient accommodation both the far point and the near point may be virtual, and the location of the latter will have to be found by placing a sufficiently strong plus lens in front of the eye, and

en making the test the same as in myopic eyes, but allowing  
for the plus lens which is used for the purpose.

**THE AUTHOR'S METHOD OF MAKING THE NEAR TEST.**—It is not always an easy matter to get the exact near point by means of the near reading chart, for the patient is often able to read by pseudo-accommodation, the power of reading slightly blurred images. Some patients will pronounce the letters perfectly clear when they may be out of focus as much as a whole diopter. To meet this difficulty the author uses a special form of near test. It consists of a ruler on which there is freely movable a cardboard slider containing three vertical targets, on each of which are drawn three fine black vertical lines, the distance between targets being two inches, though this distance may be made less. To use the device, rest the ruler against the cheek bone under the patient's eye and push the slider up as close to two inches, but for the reasons above stated this is not always the case blurred; if not they may be made so by placing a suitable lens before the eye. Next the apparatus should be withdrawn slowly until the lines on the two outer targets become clear, while the inner one remains blurred. The near point will then be marked by the middle target.

**THE PATIENT'S READING DISTANCE.**—This does not mean the distance at which he wants to read when he comes to have his eyes examined, but rather that point where, considering the length of arm and other anatomical points, it will be the right place for him to read when he takes an easy position. The condition of his eyes after fitting will also have something to do with it. It is often assumed that the reading distance should be exactly one eye as it will go. Usually the lines on all three targets will

case. Have the patient, with a piece of blank paper in his hand, take that position which is most comfortable for him. Measure the distance from the eye, and make a note of the same.

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## CHAPTER V.

### TESTS FROM THE TRIAL CASE.

When the preliminary tests have been completed the optometrist will usually have a pretty close idea of what is wanted in the way of glasses, and what is left for him to do is to determine that condition with accuracy. To this end he should proceed methodically and according to some chosen system. As to what system shall be followed in routine cases, that is a point on which there is apt to be some difference of opinion. The method given here is the one which the author has found in his own experience to be the most satisfactory in ordinary cases. In the extraordinary cases he has always been prepared to use some other special test,\* whichever one seemed to best fit the circumstances of the case. The regular routine, then, will be as follows:

ARTIFICIAL FAR AND NEAR POINT.—If the case is one of myopia, as shown by the tests already made, it will not be necessary to test for the artificial far and near point, since the information sought has already been gained. When this is not true, however, a plus 4 diopter spherical lens or a stronger one should be placed in the single cell trial frame over the right eye. (As a

\*Subjective Tests for Difficult Cases; Frederick Boger Publishing Co., 1 Maiden Lane, New York.

matter of routine it is best to always commence with the right eye in all tests and examinations.) The use of the plus lens is not only to get the artificial far point, but also in cases of spasms of the accommodation to unlock the spasm, which will usually take place in a few moments after the lens has been put in place. Now take the reading chart, simply illuminated from a light from behind and a little to one side of the patient. Move the chart away from the eye to be tested until the letters on it are all a blur, and then bring it gradually nearer until the point becomes clear. This will be the artificial far point with the plus lens used. Measure the distance from the eyes, convert it into the corresponding dioptric value by dividing into 40, and make allowance for the plus lens used. The answer will be the approximate correction for distant vision. When we put a plus 4 lens before an emmetropic eye, the far point is brought from infinity up to 10 inches or less. If we find with this lens that the artificial point is not 10 inches, then the eye is not emmetropic. If this far point is at 13 inches, which corresponds to plus 3 diopters, then to bring it up the remaining distance to 10 inches, or 4 diopters, we would have to add the difference between plus 3 and plus 4, or plus 1 diopter, which is therefore the approximate measure of the ametropia. If, on the contrary, with the plus 4 diopter lens we find the artificial far point to be at 9 inches, which corresponds to 4.50 diopters, then the eye may be .50 diopters myopic, though sometimes this will not be exactly correct, since the sense of nearness may induce a certain amount of ciliary spasm.

After the artificial far point has been noted, then the reading chart would be brought still nearer until it blurs again, this time because it has been brought within the nearest point at which it can be made out with all of the accommodation in force; by now moving the chart a little back again the point will be found within which the letters will not blur. This is the artificial near point.

r this particular eye with the plus lens. Note this distance and convert it into the corresponding diopters as before. Sometimes, where the plus 4 lens does not work out right, a higher power will have to be used, but the principle is the same.

A large proportion of the patients will have no difficulty in making out the smallest type on the test chart both for this artificial far and near point, but there will be others who will not be able to do this. Such a result would argue amblyopia, or astigmatism, and note should be made accordingly. To suit these cases, attention should be paid to the smallest type that can be deciphered.

**AMPLITUDE OF ACCOMMODATION.**—This is the extent to which the ciliary muscle can contract, expressed in diopters. To find out how much it is, we deduct the far point from the near point, expressed in diopters. For instance, if the artificial far point is found to be at 16 inches and the artificial near point at 5 inches from the eye, then the amplitude of accommodation for near, which is usually a little different than for distance, will be  $5\frac{1}{2}$  diopters, for 16 inches corresponds to  $2\frac{1}{2}$  diopters and 5 inches corresponds to 8 diopters, and the difference between the two will be as above stated. The amount of the amplitude of accommodation will vary with the individual and his age. The table by Donders, as given below, will apply to most cases, and where the actual amount in any case as tested out is less, then there will be a suspicion of paralysis of the accommodation, or spasm of accommodation, or a mistake in the age of the patient.

Years.	Amplitude in D.	Years.	Amplitude in D.
10	14.	45	3.50
15	12.	50	2.50
20	10.	55	1.75
25	8.50	60	1.

30	7.	65	0.75
35	5.50	70	0.25
40	4.50	75	0.00

FINDING AND CORRECTING THE ASTIGMATISM ERROR.—The correction of astigmatism is one of the greatest difficulties which stands in the path of the optometrist. To be certain in this branch of testing requires constant watchfulness. There are two theories as to the way in which an astigmatic eye sees. One is that it accommodates for an intermediate position between the two principal meridians, so as to reduce the blurring to a minimum, and undoubtedly in some cases this is true. The other is that the eye first adjusts for one meridian and then for the other at right angles. This action is assumed to be extremely rapid, the two images being continually superimposed. If this latter theory is correct, we have a good explanation of two important points; one why so many astigmatic eyes see so much better than ought to be the case, and the other why small errors of astigmatism produce in some cases such marked eyestrain and reflex symptoms. In any event, no matter which theory is correct, one thing is certain; the accommodation is usually in abnormal play, and unless we force this to relax we stand little chance of getting the true principal astigmatic meridians. But this is not all. Where the meridians are oblique the prescription may be wrong, either because of an error in copying on the part of the optometrist or because the glasses are set wrong in the frame, usually the former. A spherocylinder with axis 120° will become 60° if turned the wrong side out in the frame. Also it is quite evident that with oblique meridians it will not do for the spectacle eyes to be reversed in the frames, since a right lens with axis 60°, for instance, would not be correct if put in the left eye wire. To show that the optometrist may readily make

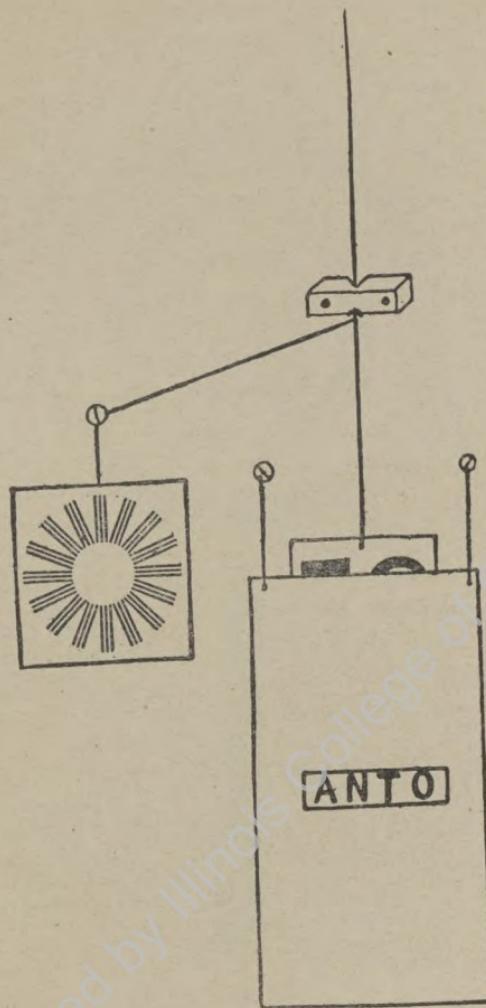


Figure 30.—An Adjustable Outfit.

an error in the case of oblique axes and meridians, let him try the following experiment: Hang the clock dial chart on the wall. On a table on the opposite side of the room place a trial frame just as it would be were it on a patient's face, or it may be placed on some one's face. Now look at the clock dial and select the lines from V to XI; decide with what degree of the trial frame these lines correspond. Now take a ruler, place it over the lines from V to XI; then, holding it rigidly in this direction, carry it across the room to the frame and see if it marks the number of degrees decided upon at first as correct. Not every one will get it right, since the lines from V to XI will be found to correspond to  $60^{\circ}$  and not to  $120^{\circ}$ , and the lines from IV to X will correspond to  $30^{\circ}$  and not to  $150^{\circ}$ .

The first step, then, in the correction of astigmatism is to properly locate the principal meridians, and this cannot be done with certainty unless the accommodation is relaxed during the test; neither will the result be attained the most smoothly unless the patient receives first such explanation as will give him some idea of what you are trying to do.

Remove the plus 4 diopter or other fogging lens used from before the patient's eye and let him examine the clock dial chart in his hands. Call his attention to the fact that it is arranged somewhat like a clock. Have him notice that in each direction there are three parallel black lines with two white spaces between. Next estimate his approximate correction for one meter. This is obtained from the artificial far point, as already shown. Put the appropriate lens in the adjustable trial frame, properly centered, turn the letter chart to the wall, hang the clock dial in position, so that it is on a level with the eye to be tested. Ask the patient if he sees all the black lines with intervening white spaces equally distinct, and if all their edges are sharply defined. Do not ask "which line is the blackest." Some people's idea of

black line takes into consideration not only the intensity of the blackness, but the retinal area of its image as well. Now increase

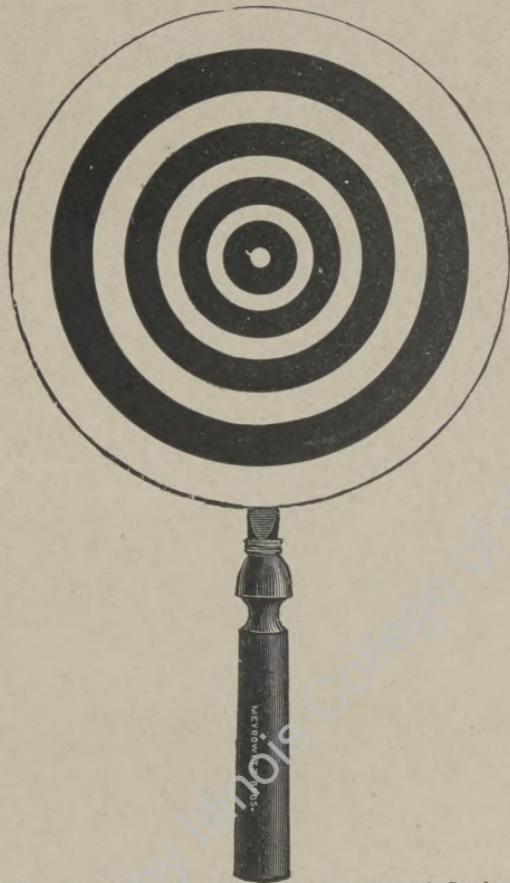


Figure 31.—Placido's Disc, for Examining the Corneal Surface of the Eye.

the power of the lenses, if plus, or decrease the power, if minus, until all the lines on the chart are blurred. Then take the clock

dial from the wall and, holding it with the VI to XII lines exact vertical, steadily approach the patient. Direct him to tell you which series of lines come out clear the first. These will show the axis of the plus cylinder required, or at right angles to this is the axis of the minus cylinder to be used.

Place the clock dial back on the wall, and decrease the power of the lens in the frame just enough, if a plus, or increase it, if minus, until the patient again sees the lines of the most defective meridian clearly, while all the others are more or less blurred. Now apply minus cylinders with axes at right angles to the blackest line, which is always the most defective meridian, until all the sets of radiating lines are alike.

Should the method of procedure as stated above develop no difference in the lines, then there is no appreciable astigmatism in that particular eye.

CHECKING UP ON THE LETTER CHART.—Leaving all lenses in place, remove the clock dial, and direct the patient's attention to the letter chart. Let him read down as far as he can. Now shift the axis of the cylinder, if the previous test has shown astigmatism, from side to side, to see if vision can be improved. It will sometimes happen that the axis is off a few degrees and this procedure will disclose the fact. Next, in cases of medium and high cylindrical corrections, call the patient's attention to the chart as a whole and ask if it seems perfectly rectangular, or whether it appears slanting. Shift the axis of the cylinder again if necessary until this appearance disappears. The usual final test in cases of astigmatism is the ability to best read the smallest letters possible, but where rectangular objects seem on the slant, this ought to be cleared, even at the sacrifice of a little acuity of vision.

THE FINAL COMPARATIVE TEST.—The optometrist

ay be sure that the finding as above given is the right correction as far as the cylinder is concerned, and a succession of tests with intervening periods of time will, in case of healthy eyes, give the same result. It now remains, however, to get the spheres exactly right. For this we should first change the letter chart, since by this time many patients will have memorized the letters. We are to depend on the sense of contrast, which is an extremely discriminative ocular faculty. Take in one hand a plano, and in the other a plus .50 sphere. First hold the plano in front of the correction already in place in the frame, wait a few seconds, and then substitute the plus .50, and ask if the latter has caused a slight blur, making sure first, however, that the patient knows what you mean by the word "blur." If the plus .50 does not blur, then take in one hand a plus .50 and in the other a plus 1, and repeat the test. Whenever the increase of .50, as stated above, produces a blur in the chart, then the correction which does not blur is the one desired. Should the plus .50 in the first place blur, then try a plano in comparison with a minus .50, trying the latter first. If necessary, compare a minus 1, and a minus .50 in the same way, the minus 1, to be tried first. The reason why a plano should be used as described is that with patients of sharp vision the chart will be pronounced blurred because of a slight dimness caused by the absorption of light by the glass of the lens itself. Glass absorbs light, and with very sharp eyes this fact should be reckoned with. The point will be, perhaps, better realized by the following experiment: Look first through an open window and then through the window glass. The difference will be quite noticeable, no matter how well cleaned the window glass may be. Should the test as made seem to show that even with the plano lens the patient is confusing the dimness with blurring, then a tinted plano may be used to make sure.

In some cases it will be possible to do finer work than the

above; that is, where the visual sharpness is very acute, the comparative test may be made with differences of .25 D., or even in some cases with .12 D. On the contrary, where the visual sharpness is low, the test may have to be made with difference of power of 1 D. or even more.

Never accept as a finality a patient's statement that he "sees better." Have him prove it by his ability to read smaller letters on the chart.

CHECKING UP AT THIRTEEN INCHES.—In cases of doubt the following may be added to the above: Combine a plus .3 sphere with the correction for distance already in the frame. This should make the artificial far point at about 13 inches, and if on testing with the near chart for the artificial far point this does not prove to be the case, then something is wrong; either a mistake has been made, or else latent hyperopia has not been all made manifest.

A DOUBLE CHECK TEST.—When the eye has been fitted and the full correction for distance is still in place, hold a plus .25 sphere in front of the other lenses in the frame. The type should blur a little. Next, with the plus .25 still in place, bring in front of it with the other hand a minus .25 sphere. The type should come clear and sharp at once. A plus and minus .50 may be used in the same way for eyes of sub-normal acuity.

THE PIN-HOLE TEST.—Whenever the visual acuity cannot be brought up to normal this test should be used. With it the test letters will never look so bright and clear, but where the sub-normal vision is due to optical defects of the eye alone the patient will be able to make out smaller letters on the chart with the pin-hole disc than without it. This is due to the fact that the

Very small hole in the opaque disc cuts down the angle or aperture so much that diffusion circles on the retina are made extremely small, thus permitting outlines to be more easily followed. Where sub-normal vision is due to some condition not optical in nature, then vision through the pin-hole will not be improved, but usually will be made worse. In placing the pin-hole disc before the eye be sure that it is properly centered for the pupil. It will be found more satisfactory to have a special holder with a handle for the pin-hole disc, so that the patient may adjust it for himself. Where the visual acuteness is very poor it is a good plan to use the pin-hole disc as the very first test, so as to get some idea of the correction by lenses as soon as possible. Where with pin-hole disc vision is improved, but a similar result or better point cannot be reached with lenses, then irregular astigmatism is present.

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## CHAPTER VI.

### TESTS FROM THE TRIAL CASE (Continued).

THE LENS PRESCRIPTION.—After the dioptric condition of the eyes has been determined, the next question is what to prescribe. The rule followed by some is very simple: Give the full correction and insist that the patient wear it through thick and thin until it becomes acceptable and comfortable. This method takes no account of previous physiological habits. It is based on implicit obedience on the patient's part, and often fails, for the reason that the average individual in wearing glasses will reach a decision as to their fitness at the end of a very short time, long before he has had a chance to "get used to them." In deciding this question he has no consideration for anything but his own feelings; he does not compare his old visual acuity with his new; he forgets all about it, but simply knows that the glasses are uncomfortable, which was not the case with the old ones, and hence he rejects them and visits some other optometrist who may not be so fixed in his ideas as to the necessity of always giving a full correction. The scientific fitting of lenses to the eye, with due regard to acquired and natural ocular functions, is a delicate problem which must be settled separately for each case. The

points to be known are the dioptric condition of the eye; the glasses previously worn, if any, and the rules of physiological habit. Especially is this true in medium and high defects and in anisometropia. In the first place, with adults, when astigmatism requires only .25 cylinder for correction, and there are no troublesome symptoms, it will usually be best to disregard the cylinder altogether. In the second place, while no regular rule can be laid down to fit all cases, it will be good routine practice for the first pair of glasses to allow the ciliary muscles to do a portion of the work, and in the succeeding ones to gradually cut down the amount of this work if the circumstances seem to require it.

Where one of the eyes is amblyopic it will sometimes be best to let one eye be fitted and disregard the other, though recently quite a movement has arisen to first correct the best eye with one pair of glasses for ordinary use, and then by special lenses to develop the poor eye, unless the difference between them optically is too great. To this end a special pair of glasses is given in which only the poorer eye is corrected; these practice glasses to be used at regular intervals, say three times daily, the good eye meantime being stopped off. Later, if the poor eye can be worked up to the other in visual acuity with proper correction, a pair of glasses is given correcting both eyes.

Again, in cases of anisometropia the question is whether to have one eye for reading and the other for distance, or to try to make both eyes work together. Where the difference between the two eyes does not exceed 1 D., the latter method can eventually be used, but where the difference is greater than 1 D. this method will usually prove impracticable. In any event, if the attempt is made to get the two eyes to work together the first glasses prescribed should only allow for one-half of the difference of the two eyes, or less, to be followed later by a correction with the full difference. In each case the patient must wear the glasses

constantly, or the method will be of no use. One objection to fitting cases of anisometropia in this way is that the patient becomes dependent on his glasses, and if by any mishap they are broken he will be put to a great deal of annoyance until they are repaired.

In the case of high myopes it will be found often that the power of accommodation is more or less diminished from non-use; hence the glasses prescribed should not throw the near point out too far, but the lenses should be made as strong as possible consistent with comfort, and the patient should return later for a stronger pair. Eventually and as soon as possible the full amount of the myopia should be corrected.

THE BINOCULAR TEST FOR DISTANCE.—This, of course, would be omitted in the case of one-eyed patients, of which the optometrist will occasionally have a case. After each eye has been fitted separately, the binocular test should be made. Have the correction selected for distance, in accordance with the previous paragraph, in place. Let the patient look at the smallest letters on the distant chart that he can make out. Now, with an extra pair of plus .25 lenses, see if the glasses will be more acceptable with this addition; try the same thing with plus .50 and with minus .25 and minus .50 spheres. It will usually be found that there will be no need to make any change where the eyes are alike. Where this is not true, however, whether because of differences in refractive power or in the axes of meridians or astigmatism, or both, it may be necessary to make some changes in the relative strength. For this purpose use the lenses as given above, also similar cylindrical powers, not over the two eyes together, but over each in turn. For instance, suppose there is anisometropia of 1 D., and suppose we have decided to make a difference in the two glasses of but .50 D., arguing that the eye

muscles are to be half relieved of the discrepancy. We may find it get comfortable that we will have to cut the difference down to .25, or, on the other hand, we may be able to go up. Each individual case is a law unto itself in this regard.

GLASSES FOR COSMETIC PURPOSES.—These are given in the case of the blind, either in one eye or both, where the misfortune is noticeable. For a person totally blind, blue or smoke glasses are usually given, but ground glass lenses will be less conspicuous. In the case of a shrunken eye, it is advisable sometimes to fit with a strong glass, which by its magnifying power will make the two eyes look of the same size.

READING LENSES.—The usual method is to estimate the reading correction from the finding for distance on the basis of the age of the patient, and then modify the correction, if necessary, until the patient is satisfied. It is usually assumed that the prescription of glasses for reading is an easy matter, but in altogether too large a proportion of these cases the result in the end is not satisfactory. To correct theoretically a case of presbyopia is simple enough, but to do so to the satisfaction of the wearer of the glasses is quite another matter. Suppose we take the case of an emmetrope, or one who is nearly so. The patient has had to hold the print farther and farther from his eyes, until at last his arms are too short for the purpose. Under these circumstances he is forced to come at last to the optometrist for glasses. The latter makes his tests and finds the distant correction, asks the patient's age, and then figures the near correction on the basis of a reading and working distance of 13 inches. Apparently the lenses are excellent, the patient is delighted and feels that now his troubles are over, but in a few days he returns. He reports that he can see all right so far as clearness of vision is

concerned, but that he simply cannot wear the glasses prescribed; that they are not his fit; that some one has made a mistake.

The cause of the trouble is this: He has been fitted for 13 inches. As a result of previous presbyopic experience he has learned, unconsciously, that to see at this short distance he must make a tremendous ocular effort; and in spite of his new glasses he still tries to make it, the result being eyestrain. To relieve the disagreeable symptoms he pushes the print farther back, as he used to, but this makes the type either blurred or not so distinct, and so he brings it back to 13 inches again, regardless of the eyestrain, until he loses patience and comes back to get the "right fit." These symptoms also are accentuated by the strain put upon his convergence, a convergence which he has not used to such an extent for years. So common is this experience in a more or less marked degree that there are many optometrists who, when asked which are the most difficult cases to fit, will answer promptly, "presbyopic ones."

In prescribing glasses for reading and working, to get the greatest satisfaction, there are several points to be taken into consideration: the near point with the distance correction in place; the amplitude of accommodation; the point at which the patient should read to be in the most comfortable position; the point at which he has previously been reading; and, most important of all, the glasses which he has been wearing, if any. The distance at which the patient ought to read ordinarily depends upon his build, unless amblyopia be present, but when he has been reading with arms too far outstretched it will be necessary at first to select a new point only a little inside of this, even if it does seem too far away. Later he will have to return and get stronger lenses which will bring his reading point to the right place.

Where the presbyopic patient has been wearing reading glasses which have become unsatisfactory, it will usually be be-

cause of increasing age and consequent loss of accommodation, though it may be due to incipient cataract or retinal failure. In these cases it is an open question whether it is always necessary to go through the complete routine of examination. If the patient has normal vision and no eyestrain or defects of vision for the working distance, except that his glasses are no longer strong enough, it may not be necessary to do anything more than to add in the + .50 or + 1. diopter required, but where the vision is not normal, then a rigid examination is usually best, though if the test with the concave retinoscope mirror reveals opacities the difficulty is probably cataract, in which event the best and simplest way is to advise the oculist.

THE BINOCULAR TEST FOR NEAR.—With the near correction in place, have the patient take in his hand the near reading chart and hold it at the reading distance for his case. Now cover first one eye and then the other, to see if one eye sees better than the other. In case one eye is better, alter the correction by an additional plus or minus .25 or more to try to make both eyes alike. Try the same method on the other eye, if necessary. If there should prove to be considerable difference in refraction of the two eyes, try the following: Have the patient scratch the smallest letters of the reading chart; then by minus lenses of low power before the eye, or plus lenses of low power before the other (in addition to the correction already in place) see whether there is any difference in the comfortable feeling of the eyes by slight changes in the power of either eye. It will usually be found that where the difference between the eyes is more than .25 D., that this will have to be at least halved. The reason why there should be a difference in the eyes at short distance and not so far is that the accommodation of the two eyes does not always work in harmony. Where there is a difference

between the two eyes at the working distance, and it cannot be corrected by lenses, then it is due to an impairment of vision, and the patient should be told, though the difference will often be so slight that no further attention need to be given to the matter.

THE TEST FOR SPECIAL DISTANCE.—Patients must sometimes be fitted for special distances, as, for instance, musicians and printers; for the former the test chart should be musical notes of various sizes. If these cases are simply presbyopic, then the matter is easily arranged; but where there is recent amblyopia due to ocular changes, then trouble may be expected, for it will be found that when the very best correction is in place, whether for type or musical notes, as the case may be, the patient will not see sufficiently well for his purpose. To get a patient of this class to work at closer range than the specified distance is usually impossible, and yet stronger lenses cannot be prescribed unless the work is to be held closer. The optical rule is very simple; the more powerful the lens, the closer the print must be, as is quite clear when we consider magnifying glasses. The patient, however, as described here, will not accept any such dictum, but demands glasses that will give him what he wants. He will claim that this is what optometrists are for. Of the same general nature as the above is the patient who insists on reading at a certain distance when the condition of his eyes, usually amblyopic, requires that he read at a shorter point. When the optometrist gets a patient of this kind, and cannot convince him of the natural limitations of lenses, he should decline to supply glasses.

#### FITTING FOR CLOSER THAN THIRTEEN INCHES.

—It sometimes happens in cases of amblyopia, often due to cataract or abnormally small pupils, that the patient must be fitted

a closer distance than 13 inches. Sometimes it has to be as  
as 4 inches or less. It is doubtful as to whether the optom-  
erist should touch these rare cases, but if he does it is better to  
one eye only, so as to avoid the extraordinary strain of undue  
convergence. The writer has fitted a case of this kind, myopia  
combined with cataract, for a distance of 2 inches.

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## CHAPTER VII.

### VARIOUS LENSES USED IN GLASSES.

VARIETIES OF LENSES.—The standard lenses for first-class work are periscopic, the concavity in plus lenses being on a minus curve of 1.25 D. of power, the concavity to be placed next the eye. Where there is a minus cylinder present and the axis is horizontal, the cylindrical side of the lens is placed towards the eye. In periscopic glasses for myopia, which have a plus curve of 1.25 D., it is the concave side which is placed next the eye. In other cases the lenses are so set that the surface which interferes the least with the up and down motion of the eyebrows is on the inside. Occasionally periscopic lenses are unsatisfactory, and it is then necessary to give some other form, such as plano-concave, bi-convex, plano-convex or bi-convex, as the case may be. Why these should be accepted as comfortable, and the others not, is not at all clear. It is usually stated that there is a "glare" with the periscopic form which does not exist with the others, though why so few of the vast number of those who wear the periscopic form should notice this "glare" is a puzzle.

LENTECULAR LENSES.—In cases of high ametropia, where the weight of the lenses prescribed becomes an important factor because of their pressure on the nose, "lenticular" lenses are prescribed. These have a small center of the required diop-

power, while the balance of the lens is ground down to a thin glass plate, thus reducing the weight considerably. It is true that they restrict the field of view, but this does not seem to be noticed by those who wear them.

**BIFOCALS.**—Where the patient must wear corrections for both far and near vision, two pairs can be described, or else bifocals. There are several forms of these, as may be seen in the dealer's catalogue. It takes the patient some little time to get used to bifocals, as the portion correcting for reading is apt to get in the way when the patient looks down. This is especially troublesome when he is going downstairs; in fact, the patient should be cautioned in regard to this. Once, however, accustomed to bifocals, those who wear them are usually pleased and willing to take any others.

**CLERICAL LENSES.**—These are the ordinary style of glasses, periscopic or otherwise, as the case may be, with the tops ground off. They take the place of a bifocal where the patient is emmetropic, or nearly so, so that glasses for distance are not needed. Sometimes, in the case of myopes, they are ground the other way, the bottoms off. Occasionally it is also necessary to cut off the tops of lenses to allow them to set under projecting eyebrows. These lenses take their name from the fact that they are used principally by clergymen.

**TORICS AND INVISIBLE BIFOCALS.**—These are two forms of considerable expense, which for those who can afford them are rapidly coming into use. The "toric sphere" is a shell-shaped glass; for a plus 1. D. it might have a minus curve of 6 diopters on one side a plus 7 on the other. The outer surface of these lenses, acting as a rather strong convex mirror,

produces an effect of brilliancy which gives a peculiar charm and distinctiveness to the face of the wearer.

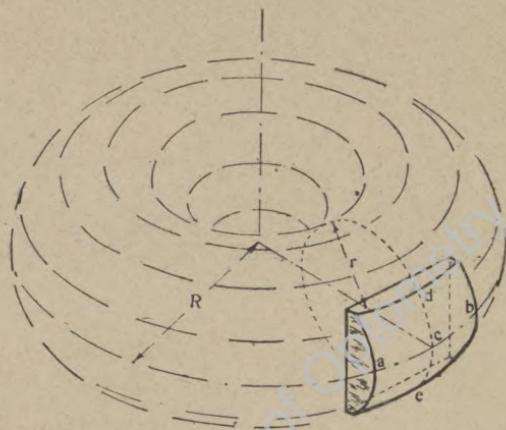


Figure 32.—The Nature of a Toric Lens.

**THE TORIC LENS.**—This corresponds optically to a spherocylinder. On one surface there is a spherical curve, while on the other the curvature is that of a toro. Such a surface when tested with a lens measure will show different power in different meridians on the same surface. With both the "toric spheres" and the toric lenses proper there are sometimes complaints, similar to those in regard to periscopic lenses; hence it is necessary sometimes to give spherocylinders instead.

**FUSED BIFOCALS.**—These are made of two pieces of glass of different refractive indices, so made that the wafer that

the added power for reading is in the body of the main or once lens, being fused into place, the two powers forming one lens. These lenses make the finest appearance, and are by the most durable and satisfactory of all the varieties of bimill lenses.

**TINTED LENSES AND PLANOS.**—Photophobia, or insensibility of light, is usually a symptom of some pathological condition, and hence the cases are hardly optometrical. Nevertheless there are cases where the patients demand these glasses, and have them. Under these circumstances "tinted" glasses will be prescribed. There have been many colors and tints tried for special purpose in the past, but in view of the nature of the retina in reference to the waves of light, smoke is the only tint should be recommended. The retina is adapted for the reception of all the component parts of white light, and smoke bases do not cut any of these off, but simply reduce the intensity of all. On the contrary, tinted glass deprives the retina of the stimulus of the color which it cuts off, or absorbs, and this may produce retinal tire, and if the wearing of the colored glass is persisted in there will be permanent retinal fatigue. To understand what is meant by retinal fatigue for colors, take a piece of paper and place it in the center of a sheet of white paper in bright light. Stare at the blue paper steadily for about half minute, then, with the eyes fixed, suddenly withdraw it. In a moment or so a strong after-image will appear on the white paper where the blue piece had been placed. This will be of reddish color and very vivid. It means that the white light from the card which falls on that spot of the retina, in this case the macula lutea, where the image of the blue had previously been, is not all gone. We do not see the blue in it, for the eye is tired for blue. What we see is the white with the blue left out, which is reddish.

DUG

Those of us who have gone to the theatre and seen the play or the calcium lights will recall that, while the beauty of it was striking, still the return of the white light was a relief.

**PRISMS.**—These are prescribed sometimes in heterophoria; but many cases of heterophoria disappear after the correction of the ametropia. Some authorities claim that all heterophorias are due to refractive errors, and that prisms should never be used; others do not go so far as this, but in any event the first thing to do in heterophoria is to correct the ametropia, and then wait a few weeks. In other cases the heterophoria is not noticed; it gives no trouble, and therefore no attempt should be made to correct it. Aside from the above-mentioned cases, there are somewhere the heterophoria persists, and with these prisms should under certain circumstances be prescribed. These cases will now be discussed further here.

**KEEPING RECORDS.**—If the method of partial correction at first, and the gradual increase to full correction later, is followed, as recommended here, then records must be kept, not only of the lenses which are prescribed, but of the dioptric conditions on which such prescriptions are founded. As to the style of record to be kept, each one should devise his own. In it there should be all the points that have been described here, including a brief history of the case. Such a record, properly indexed, may save a great deal of future trouble, as well as necessity for re-examinations.

## CHAPTER VIII.

### SOME USEFUL INFORMATION.

CHILDREN AND SCHOOL LIFE.—It is an open question as to whether the eyes of many children are equal to the demands of modern civilization. When we consider the age of the world, and then the development of modern printing and its use in schools, we feel that it is going to take many thousands of years before all eyes will be fully altered to fit the continuance of present school conditions. Fine print and sewing are bad enough, especially when they are made part of a kindergarten course, but when we add to this musical notes written in small type it is not all strange that eyestrain should be so prevalent.

In the case of books used in schools there has been a steady improvement, which has, however, for economical reasons, not gone far enough. Every school book should be in large type, well spaced, with narrow columns, and not on glazed paper. This will reduce the strain on the vision to the lowest point. But the uniform should not stop there. There is the question of desks. Every child should have a desk to fit him, and these are to be had in the market. Some schools use them. Where the desks do not fit, then, the body not being properly supported, the muscles begin to droop; the child to be comfortable comes too far to his work, and eye troubles are the result. In other cases,

however, the weariness of the effort is the main point, and the child ceases to be a scholar.

Child nature has been studied a great deal, but the limitations of children's endurance is as yet not one of the courses given to teachers. Children should have frequent periods of rest a great deal of their work, especially in arithmetic, should be done standing at blackboards on which dustless crayon is used; when small they should have no home tasks at all; in the grammar schools these tasks should be light and few, though beyond that point they seem to be an unavoidable part of modern school life; the light in the schools should be of the right kind and from the correct direction—from the left; under no circumstances should their eyes face the light. The teacher should keep records of the eyesight of the pupils; not scientific records, but simple ones which will not require on her part more than an hour of study to understand and possibly two or three hours of the whole session to make and keep. In the case of those children who fail on the simple sight tests given, notices should be sent to the parents, and where these notices are disregarded they should be followed up by further ones.

MYOPIC CHILDREN.—Myopia is the scientific name for near-sightedness. A near-sighted child can see well near by, but not at a distance. Such a child does not like to play with his fellows, as he is always the one "caught." Myopia in school children tends to grow steadily worse. The myopia may develop into cases of disease, and where this is not the case the child is robbed of most of the enjoyment of life. Myopic children are usually unchildishly sober in demeanor.

WHEN SHOULD A CHILD WEAR GLASSES?—In the first place, any child old enough to study, and who has to study,

d wear glasses if his eyes are not normal. This will be  
in in several ways: difficulty in seeing either near or far;  
in the eyes; headaches. School life is an important piece  
of business, and since almost the only sense used in schools is  
sight, and this sense is used to excess, every child's eyes without  
exception should, before commencing school life, be examined  
in order to see to what extent he is prepared to take up the work.  
Knowledge under modern conditions is an absolute necessity, but  
good vision, hence no chances should be taken. The idea that  
eyes are right and more or less alike is about as true as to say  
that all people should be of the same height or weight, or color  
of hair, or state of health.

OVERWORKING THE EYES.—It is strange how some  
people will overwork their eyes. They will rest their backs when  
they sit, but for a tired eye they have no mercy. They will not  
allow their voices to excessive exercise, by screaming, for in-  
stance, but they will read on the cars, or read when sleepy, or do  
any work, not because they have to, but because they take  
pleasure in it, though the eyes are rebelling all the time. They  
will read poor type, and small type, though their eyes are mean-  
ingless, as they force the owner of the eyes to wear spectacles  
earlier than would otherwise be the case, yet every one with  
normal eyes must wear glasses for reading sooner or later. That  
is the order of nature. But though no one likes the idea of put-  
ting on glasses, still he will do those very things which make the  
wearing of glasses unduly early a necessity. When such a one  
is forced to come at last to the optometrist, and wonders why,  
the reason is simple. He has overworked his eyes and must pay  
the penalty.

WHEN SHOULD GLASSES BE WORN?—When one

does not recognize his friends on the street; when he has to turn the light very high to see to read; when he has to hold the print too far away from his eyes; when he has to hold the print under his nose; when his eyes ache or water; when he has headache which headache powders won't cure; when things look misty or double; when his eyes trouble him in this way it is time for him to have them examined.

DROPS IN THE EYES.—This is the expression used when atropine or similar substance is put in the eye. Atropine is a poison. It is the alkaloid from belladonna, just as morphine is the alkaloid from opium. Many people would never think of having this powerful drug put in their eyes than they would to take chloroform or ether. Both ether and atropine have their places, but many intelligent people are slow to consent to their use. It is true that those who make use of atropine belittle its effects; nevertheless it may be dangerous, and sometimes produces untoward results.

PARAFFIN INJECTIONS TO IMPROVE THE SHAPE OF THE NOSE.—The eye is an organ with a circulatory system. If the circulation stops, the eye will grow blind. There is danger in the modern practice of injecting paraffin under the skin for cosmetic purposes. Some of the veins from the eye pass down through the base of the nose. In a recent case one of these veins was plugged by a piece of paraffin in injections as above stated, and the result was total blindness in a few hours.

SECOND SIGHT.—Some elderly people regain their vision by what is called second sight. This is an abnormal condition of the lens of the eye, in which it swells and gains

irrifying power. In some cases second sight is permanent a great comfort, but usually it is followed by slowly failing vision, until, if the person lives long enough, there is blindness.

#### WHAT TO DO WITH AN INFLAMED EYE.

NATURE OF INFLAMMATION.—There are three kinds of eye inflammations: Severe accident, disease, and mechanical irritation due to the presence of some foreign particle. In the first two cases the party should get to a doctor without the slightest delay. In the third case he should be recommended to go to a doctor, but if he will not, ordinary human pitying demands that we do something. Suppose there is a piece in the eye, wash the eye with a solution of vinegar in water, a teaspoonful to a cup of water, or olive oil may be used, whichever can be had the first. In case of burns by acids, use lime water from the druggist, or milk is good. In severe cases the doctor should have been sent for whether the patient agrees or not, for the injuries are apt to be very serious; and this applies with especial force to pieces of metal which have sunk into the surface of the eye.

DUST OR SAND OR CINDER IN THE EYE.—This is a very common occurrence, and every one should know what to do to help the sufferer. As a matter of fact, dust is continually getting into the eyes all the time, but tears and winking keep it working it out. Unconsciously we rub our eyes a great many times every day to get rid of this dust, which gathers, moistened by the natural tears of the eye, at the inner canthus. Then, however, something sharp gets into the eye, a cinder, for instance, it is apt to catch either on the under surface of the eyelid, usually the upper one, or the cornea itself. The

old woman's way to get rid of it is to pull out the upper lid and suddenly insert her tongue into the cavity. Not a very pleasant method, but often very effective. Another way is to run the loop of a horsehair in and draw it across the ball of the eye. This is dangerous, as the eye is apt to be infected. Some druggists sell, or used to sell, what is called "eye stones," little flat, smooth stones about the size of the scales of a fish, which would be inserted under the upper lid, and which by their movements from place to place, because of the continual turning of the eyeball, would carry out the ob-

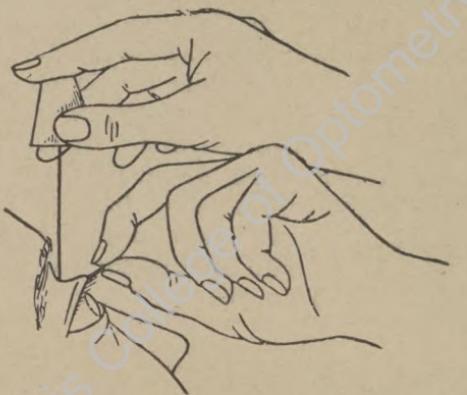


Figure 33.—Enverting the Lid.

struction. Sometimes when the druggist would be out of eye-stones he would furnish a small seed for the purpose. Here again, there is danger of infection. Still another way is to pull out the lid and blow into the eye. The best way to proceed, however, is as follows: Bring the patient near a bright light; but if the examiner's eyes are presbyopic, and he cannot

well at a close range, say 6 inches, he should put on a pair of spectacles which will permit him to do so; pull out the upper lid and see if the irritating particle is there; sometimes it is not, as the patient himself will have removed it by rubbing. Now evert the upper eyelid; catch with the fingers of one hand the edge of the upper lid; touch the center of the lid with the curve of a hairpin set in a fork, or the end of a match or penholder will do, and turn the eyelid inside out. The cinder or other matter, if not already out, will be seen at once, and can be removed with the tip of a clean handkerchief or a tuft of absorbent cotton. Remember that the irritation will cause the eye to be painful for some time, even when the cinder has been removed; also that with all your trouble and searching the particle may be so small that you cannot find it; or it may be so imbedded that you cannot remove it. In either case try to get the patient to go to the doctor for a healing collyrium. He may not take your advice, but at least you have done your duty.

HANDLING LENSES.—Lenses should never be touched by the fingers, as this soils them, which in turn may lead to errors in the subjective tests. They should be kept clean by the use of a fresh cloth each day, and should be removed from the trial case and returned thereto by the handles only.

## APPENDIX.

### MEASUREMENTS OF THE EYE (*Jaeger*).

Anterior-posterior diameter .....	24.3 mm
Horizontal diameter .....	23.6 mm
Vertical diameter .....	23.4 mm
Diameter of cornea .....	12. mm
Average thickness of cornea .....	1. mm
Average diameter of pupil.....	4. mm
Average diameter of optic nerve through sclerotic.....	1.5 mm
Thickness of crystalline lens.....	3.7 mm
Diameter of crystalline lens.....	10.3 mm

Note.—A millimeter (mm.) is very close to 1-25 in.

### APPROXIMATE PERCENTAGES OF OPTICAL CONDITIONS IN THE EYE

	Per cent
Emmetropia .....	3
Hyperopia .....	1
Myopia .....	1
Simple hyperopic astigmatism .....	45
Simple myopic astigmatism.....	1
Compound hyperopic astigmatism.....	2
Compound myopic astigmatism .....	2
Mixed astigmatism .....	100

### TEST TYPES FROM PRINTERS' FONTS (*Jaeger*).

No. 1—Diamond.	No. 8—Pica.
No. 2—Pearl.	No. 9—Two-line Brevier.
No. 3—Nonpareil.	No. 10—Two-line Long Primer.
No. 4—Minion.	No. 11—Two-line Pica.
No. 5—Brevier.	No. 12—Three-line Pica.
No. 6—Long Primer.	No. 13—Four-line Pica.
No. 7—Small Pica.	No. 14—Five-line Pica.

### TEST TYPES (*Snellen*).

200 ft. $3\frac{3}{4}$ in. square.	40 ft. $\frac{3}{4}$ in. square.
160 ft. $2\frac{1}{2}$ in. square.	30 ft. $9\frac{1}{16}$ in. square.
120 ft. $2\frac{1}{4}$ in. square.	20 ft. $\frac{3}{8}$ in. square.
100 ft. $1\frac{1}{2}$ in. square.	15 ft. $9\frac{3}{32}$ in. square.
80 ft. $1\frac{1}{2}$ in. square.	10 ft. $3\frac{1}{16}$ in. square.
60 ft. $1\frac{1}{2}$ in. square.	$7\frac{1}{2}$ ft. $9\frac{1}{16}$ in. square.

## RECORD OF CASES.

Name .....  
Address .....  
e .....

## HISTORY.

Difficulty in seeing far? .....  
Difficulty in seeing near? .....  
Headaches? .....  
Are eyes tired? .....  
Is there watering? .....  
Are there tears? .....  
Is there astigmatism? .....  
Are eyes sensitive in morning? .....  
Is there double vision? .....  
Special Symptoms? .....  
E. Finding .....  
E. Finding .....  
E. Prescription for distance .....  
E. Prescription for distance .....  
E. Prescription for near ..... inches .....  
E. Prescription for near ..... inches .....

NOTE.—The above is a sample record of the case to be kept by the optometrist for future reference. It is distinct from the prescription order sent to the shop to be filled.

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better than that of eserine, and does not act as powerfully as the latter, but is not accompanied by any unpleasant complications. Eserine is best reserved for those cases in which pilocarpine is ineffectual.

**Esoptoria** (es-o-lo'-ri-ah). A tendency of the eyes to deviate inward, usually caused by hyperopia.

**Exotropia** (ex-so-tro'-pi-ah). This term expresses a stronger meaning than Esophoria, in which there is merely a tendency, while in Exotropia there is a positive and visible appearance of the eyes turning inward.

**Excavation** (ex-cav'a-shun). Excavation of optic nerve, cupping or hollowing of the optic disc.

**Exophoria** (ex-o-lo'-ri-ah). A tendency of the eye to deviate outward.

**Exophthalmic Goiter** (eks-o-fthal'-mik go'iter). A goiter with exophthalmos and cardiac palpitation; Basedow's disease; Graves' disease. The most prominent symptoms are protrusion of the eye, excited action of the heart, enlarged thyroid (goiter), and certain nervous phenomena. The protrusion is almost invariably bilateral, though not infrequently greater on the right side. The upper lids do not follow the eyeball in looking down (von Graefe's sign); infrequency of involuntary winking (Stellwag's sign) and abnormal width of the palpebral aperture are also found.

**Exophthalmos** (ex-of-thal'-mos). Abnormal protrusion of the eye.

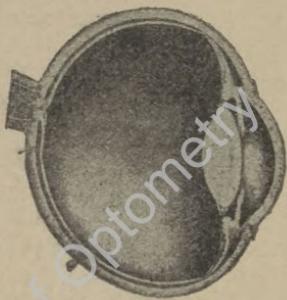
**Exorbitalism**. Protrusion of the eyeball.

OPTICAL DICTIONARY

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**Exotropia** (ex-o-tro'-pi-ah). When the eye is turned outward from parallelism. Divergent strabismus.

**Extraction** (ex-trak'shun). The removal of a body by surgical means.



Eye.

**Eye.** The organ of sight. The function of each eye, taken singly, is to form upon the retina, or nervous membrane which lines the inside and back part of the organ, a sharply defined inverted image of any object looked at. The eye resembles a photographer's camera, inasmuch as the image produced upon the retina is precisely the same as that produced on the ground glass of a camera. By means of the optic nerve the image that is received on the retina is conveyed to the brain,

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